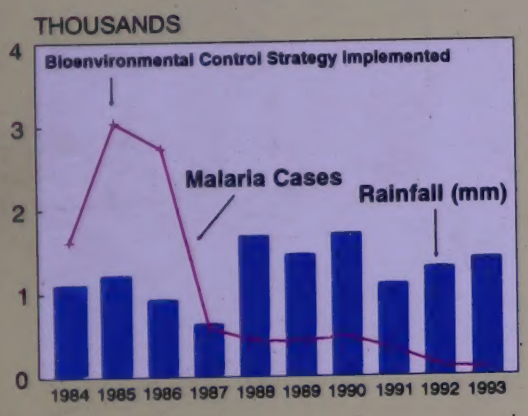
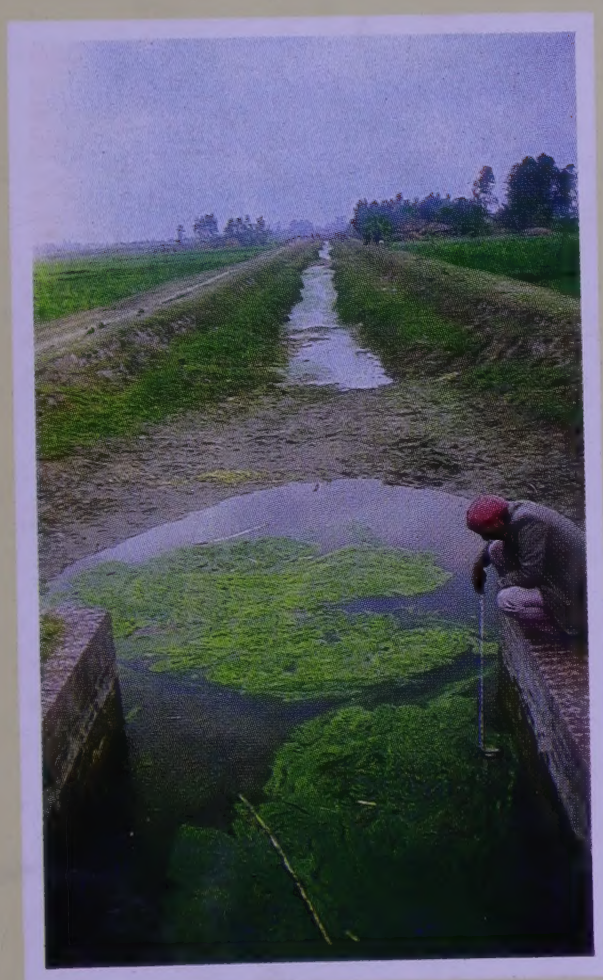
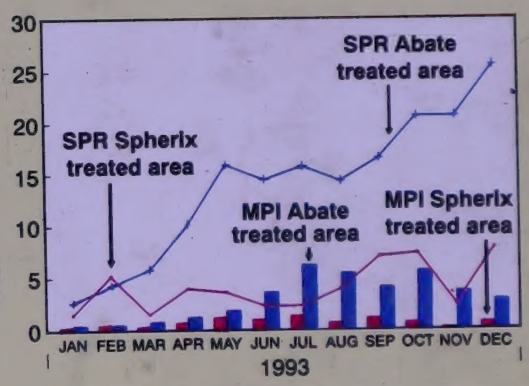
ANNUAL REPORT 1993

Science and Technology Project on Integrated Vector Control of Malaria, Filaria and Other Vector Borne Diseases







MALARIA RESEARCH CENTRE
(Indian Council of Medical Research)
22-Sham Nath Marg
Delhi-110 054

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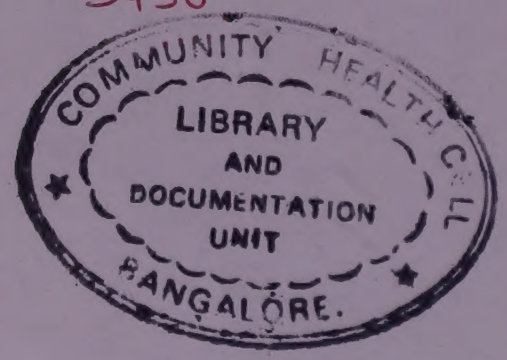

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PREFACE

Science and Technology project on the integrated control of malaria, filaria and other vector borne diseases has progressed extremely well in terms of the (i) feasibility of the bioenvironmental malaria control in rural, urban, and industrial areas (ii) trials with new technologies for their application in the control of malaria and (iii) promoting health education, community participation, inter and intra-sectoral coordination to achieve mosquito and malaria control on sustained basis. In the last few years, epidemiological studies were undertaken to define the dynamics of malaria transmission and study malaria trends.

Studies carried out by the project staff have shown that malaria situation has not changed in the hard core areas which are mostly tribal settlements in forests. Malaria is entering new areas with irrigation, and there is an increasing trend of malaria and dengue fever in the urban, and the industrial areas. The problem of chloroquine resistance in P. falciparum is increasing in the intensity, and more areas are coming under the problem of resistance. Malaria control by the NMEP in the country is being done in the traditional way by spraying residual insecticides in rural areas and anti-larval methods in the urban areas. To fight persistent malaria transmission there is need to incorporate new technologies in the control of malaria. Some technologies developed and field tested by the project staff and are ready for application in the field are (i) bioenvironmental malaria control (ii) neem oil as mosquito and sand fly repellent (iii) use of biolarvicides in vector control (iv) malariogenic stratification for planning of malaria control and (v) emphasis on early case detection & treatment. In this connection work on the transfer of technology in Bangalore and Madras is progressing satisfactorily, and action plan is being prepared for the introduction of the bioenvironmental control, neem oil and other products into the programme. New technologies such as the remote sensing, geographical information system, malaria modelling etc. are being developed for integration with the programme.

During the year appreciable progress has been made in various areas by launching multi-centric trials on the (i) role of biolarvicides (Bti and Bs) in the control of mosquito breeding (ii) mosquito breeding in the rice agro-ecosystem, (iii) repellent action of neem oil, and (iv) insecticide impregnated bed nets. Some of these studies may take another year or so before these are completed. It is envisaged to re-organize research at the field stations by re-assigning new tasks or by re-locating these units to take up new and challenging problems such as the (i) control of refractory forest malaria (ii)

dynamics of chloroquine resistance in P. falciparum (iii) P. falciparum multiple drug resistant strains and the mode of their dipersal (iii) mosquitogenic potential created by the Narmada and Sardar Sarovar Project and remedial actions in such areas (iv) Project malaria in new problem areas (v) biology of the vectors in different ecologically diverse habitats (vi) trials with new drugs (vii) preparation of curriculum and training of various category of state officers (viii) participation in the multi-centric trials on the field testing of new technologies e.g. biological control methods, (GIS) maps, their updating and utilization in forecating of malaria epidemics. Planning for all these activities has already started and in the coming year, field staff will concentrate on these important research problems.

PART I (GENERAL PROJECT INFORMATION)

1. **PROJECT TITLE:**

Science and Technology Project on the Integrated Vector Control of Malaria, Filaria and Other Vector Borne Diseases

2. **OVERALL OBJECTIVES:**

(i) Integrated vector control of malaria and other vector borne diseases in different agro-climatic regions of the country under the influence of different vector species/parasites and other socio-economic problems.

(ii) Development of cost-effective model for extension and/or duplication in similar geographical areas of the country.

ADDITIONAL OBJECTIVES (starting March 1989)

(i) District level implementation of the bioenvironmental control of malaria strategy in Gujarat and UP through the district infrastructure and primary health care system using existing resources and man power.

(ii) Preparation of mosquito control action plan for the entire metropolis of Delhi (UT) and Madras (TN).

(iii) Preparation of training manuals , video films and organization of training programmes for various categories of medical and para-medical officers, technicians, engineers, architects and officers of collaborating agencies.

(iv) Basic and applied research to support field activities.

3. **NODAL DEPARTMENT WITH COLLABORATING AGENCIES:**

Nodal department : Indian Council of Medical Research
Institute : Malaria Research Centre

Collaborating Agencies :

(i) National Malaria Eradication Programme (NMEP)
(ii) State Health Departments and Corporation/Municipalities
(iii) Local Institutions and other State & Central Govt. Departments

4. **BUDGET:**

(i) Organizationwise breakup of the cost, (yearwise)
(as given in the project document)

	Rs. in Lakhs					
Agency	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
ICMR	110	110	110	110	110	110
Min H & FW	100	150	142.50	150	150	145
Total	210	260	252.50	260	260	255

(ii) Expenditure (Rs. in Lakhs)*

	Items	1989-90	1990-91	1991-92	1992-93	1993-94
(i)	Pay & Allowances	78.22	106.08	106.80	125.66	131.49
(ii)	Transport & Equipment	28.95	24.17	29.59	9.39	3.88
iii)	TA/DA	9.30	10.54	10.44	10.68	5.48
(iv)	Other Charges	126.56	114.04	113.17	114.27	114.15
(v)	Capital	-	3.85	4.41	-	-
	Total	160.12	260.00	246.88	259.24	255.00

* For 1985-86, 1986-87, 1987-1988 and 1988-89 please see previous reports

(iii) **STAFF POSITION OF S&T PROJECT**
(as on 31.12.1993)

Name of Posts	Post sanctioned	Posted	Vacant/Excess
Financial Adviser	1	1	-
Officer on special duty	1	-	1
Dy. Director (Eng.)	1	-	1
Assistant Director (Eng.)	1	-	1
Sr. Research Officer	12	7	5
Research Officer	23	15	8
Asstt. Research Scientist/TO	25	22	3
Health Educator/ATO	21	16	5
Lab. Technician	43	43	-
Insect Collector	65	59	6
Field Lab. Attendant	95	90	5
Driver	48	59	+11
Upper Division Clerk	22	4	18
Administrative Officer	1	1	-
Accounts Officer	1	1	-
Section Officer	1	1	-
Sr. Personal Asstt/P.S.	2	-	2
Assistant	2	1	1
Junior Engineer	2	1	1
Asstt. Engineer	1	-	1
Supervisor	1	-	1
Sr. Stenographer	1	-	1
Jr. Stenographer	1	1	-
Artist	1	1	-
Photographer	1	1	-
Cameraman	2	1	1
Computer Programmer	8	7	1
Computer Operator	1	-	1
Production Assistant	1	-	1
Lower Division Clerk	24	24	-
Peon	17	16	1
Chowkidar	16	14	2
Sweeper	7	5	2
Mechanic (Electrician)	2	1	1
Draftsman	1	1	-
Duplicating Operator	1	1	-
	453	394	59

5. PROJECT MANAGEMENT STRUCTURE:

5.1 PROJECT MANAGER : Dr V.P Sharma, Director
Malaria Research Centre
22-Sham Nath Marg
Delhi - 110 054

Tel: 233743

Telex:031-78234
Fax: 7234234

20, Madhuban
Delhi - 110 092

Tel: 2247983
2215086

5.2 COMPOSITION OF STEERING COMMITTEE :
(Meeting at six monthly intervals at the ICMR HQ's office)

Director General, ICMR
Additional Director General,ICMR
Senior Deputy Director General(Administration),ICMR
Financial Advisor, ICMR
Project Manager

5.3 COMPOSITION OF EXECUTIVE COMMITTEE :

Dr. V.P. Sharma, Chairman
Mr. R.K. Chandrahas (Madras)
Dr. Vas Dev (Sonapur)
Dr. V.K. Dua (Hardwar)
Dr. A. Giri (Car Nicobar)
Dr. A. Kumar (Goa)
Dr. R.P. Shukla (Haldwani)
Dr. R.N. Prasad (Shahjahanpur)
Dr. Neeru Singh (Jabalpur)
Dr. P.K. Pujara (Nadiad)
Dr. B. Shahi (Allahabad)
Dr. R.S. Yadav (Rourkela)
Dr. Anil Prakash (Bangalore)
Dr. Aruna Srivastava (Computer)
Mr. T. Adak (MRC, HQs and Delhi), Member Secretary
Administrative Officers (S & T project and MRC)

6. IMMEDIATE OBJECTIVES:

6.1 ACTIVITIES DURING THE YEAR 1993-94

STATE, GUJARAT

(I) **Kheda district:** (i) A fish farm on genetic resource unit on larvivorous fishes of India is being established. (ii) demonstration site on bioenvironmental strategy is being developed. (iii) training for medical and other staff of the district. (iv) parasitological surveys, and (v) monitoring of Pf resistance

STATE, UTTAR PRADESH

(a) Allahabad (b) Hardwar (c) Nainital (d) Shahjahanpur

(i) Large scale field trials with biolarvicides in Shahjahanpur. (ii) repellent action of neem oil in Hardwar. (iii) rice-agro ecosystem studies in Nainital. (iv) parasitological studies in quarry area in Allahabad.

In the above mentioned four districts studies have been planned for (v) monitoring of drug resistance (vi) biological control of mosquito breeding.

DELHI, UNION TERRITORY

Delhi (U.T.) (i) Tests with new biological control agents, (ii) field trials with biolarvicides, (iii) neem based formulation for malaria control, (iv) mass production of larvivorous fishes and their dissemination, (v) Remote sensing for macro-stratification, and (vi) Geographical Information System is being applied for malaria.

MADRAS, TAMIL NADU

Madras (T.N.) (i) 7-point action plan is being implemented in Madras city, (ii) bye-laws are being implemented, (iii) Three Corporation divisions are in the maintenance phase.

STATE, MADHYA PRADESH

Mandla district: The immediate objectives are (i) mapping of malariogenic potential created by Narmada project, (ii) Work on deltamethrin and Lamdachylothrin impregnated curtains is in progress, and (iii) work on distribution and occurrence of a new plasmodium species is being emphasized.

STATE, ASSAM

Kamrup district: (i) Insecticide impregnated bednets programme is being expanded to cover larger areas in the state through the tribal welfare department, (ii) biology of An. minimus, (iii) workshops on the serious and complicated malaria, (iv) repellent action of neem oil and (v) sibling species complex in An. minimus and An. fluviatilis.

STATE, ORISSA

Sundargarh district: Mass production of larvivorous fishes and control of mosquito breeding in rice fields, mining malaria is under study. Clinical research on malaria has been taken up with Ispat General Hospital. Application of bednets for malaria control, (i) insecticide impregnated bednets in mining areas, (ii) repellent action of neem oil, (iii) large scale field trials with bio-larvicides and (iv) studies on rice fields.

ANDAMAN & NICOBAR ISLANDS, UNION TERRITORY

Car Nicobar: (i) Installation of one way sluice gates, (ii) trials with biolarvicides and (iii) mass production of larvivorous fishes.

STATE, GOA

Panjim district: (i) Studies on malariogenic potential created by Konkan Railway (ii) field trials with biolarvicides in malaria control (iii) changes in school curriculum to introduce bioenvironmental control, and (iv) introduction of legislative measures.

State Level Implementation

STATE, KARNATAKA

(i) Geographical reconnaissance of Kolar district for the introduction of bioenvironmental malaria control, (ii) preparation of a demonstration site for training.

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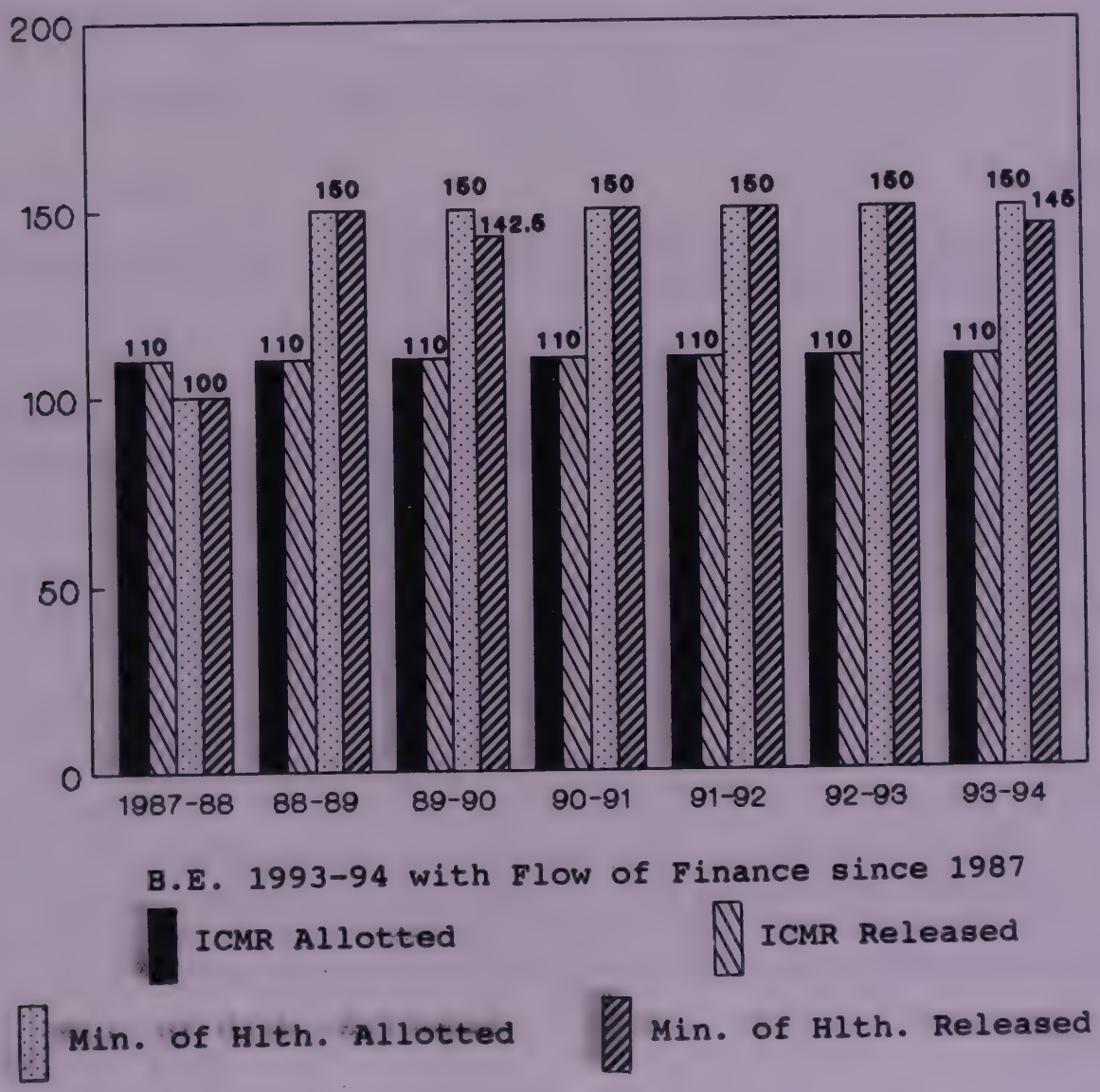
6.2 B.E. 1993-94 WITH FLOW OF FINANCE ANALYSIS

The analysis is given below which is self explanatory.



PART - II (SPECIFIC INFORMATION FOR MONITORING)

7. CARRIED OVER DECISIONS :

DECISIONS TAKEN IN THE REVIEW MEETING NO. 7 TAKEN BY SA TO PM ON JUNE-JULY 1989 AND FOLLOW UP ACTIONS TAKEN BY THE NODAL DEPARTMENT

(i) **RECOMMENDATION :**

Regarding project staff, it was agreed that FA, ICMR and Director, MRC would evolve a mechanism to solve the problem. A core staff of ICMR, as required at a particular field station and projected by the Project Investigator (Director, MRC), would be provided as regular staff of ICMR. Other project workers should be from the State Govts./NMEP on the basis of consolidated salaries etc. The core staff would be moved to new locations as and when necessary.

ACTION TAKEN :

Council has set up a screening committee to select projects which may be made permanent.

DECISIONS TAKEN IN THE REVIEW MEETING NO. 8 TAKEN BY MOS (S&T) ON 22ND JANUARY 1990 AND FOLLOW UP ACTIONS TAKEN BY THE NODAL DEPARTMENT,

The following decisions were taken:

(i) **RECOMMENDATION:**

Work on the district level implementation in U.P. and Gujarat should be vigorously pursued by the respective Health Departments. In Gujarat, one more district e.g., Surat, as selected by the State Government, may be selected for implementation. MRC will continue to provide technical inputs through its core technical/assisting staff.

ACTION TAKEN:

M.R.C. is continuously providing technical inputs to the programme for the implementation of bioenvironmental control but response from the states is not forthcoming.

(iv) **RECOMMENDATION:**

The role of remote sensing techniques in geographical reconnaissance, predicting mosquito population build up, and impending outbreaks of malaria, was highlighted. Arrangements would be made to develop linkages with remote sensing agency for application of this technology in mosquito control.

ACTION TAKEN:

One study on the mosquitogenic potential of Sanjay lake in Delhi has been completed.

DECISIONS TAKEN IN THE REVIEW MEETING NO. 9 TAKEN BY MOS (S&T) ON 13TH SEPTEMBER 1990 AND FOLLOW UP ACTIONS TAKEN BY THE NODAL DEPARTMENT.

The following decisions were taken:

(i) **RECOMMENDATION:**

Work at the district level implementation of the bioenvironmental control strategy should be taken up without further delay in UP and Gujarat. The Ministry of Health & Family Welfare would look into the planning, cost aspects and implementation mechanism etc. Initially, district level implementation would be treated as projects and a suitable mechanism would be evolved for the implementation to achieve the desired results, and from these areas NMEP operations of spraying would be withdrawn. Obviously, the implementation may not be strictly as per the existing primary health care system norms. State Govts. would be responsible for implementation and MRC will provide back up technical support.

ACTION TAKEN:

MRC is continuously providing technical inputs to the programme for the implementation of bioenvironmental control but response from the states is not forthcoming.

(iii) **RECOMMENDATION:**

Delhi site of the Science & Technology project which was till now kept separately from the Science & Technology project would be merged with the Science & Technology project along with its assets and finances etc.

ACTION TAKEN:

Delhi site has been merged with the S & T project.

(iv) RECOMMENDATION:

Core staff of the Science & Technology project should be identified by a group comprising Jt. Secretary (Health), FA (ICMR), Addln. Director General, (ICMR) and Director MRC. This core staff for each field station would be considered for regularization as MRC staff. The proposal would be submitted to the Health Ministry as soon as possible and there would be no difficulty in the regularization of the staff.

ACTION TAKEN:

ICMR has initiated action.

8. NEW S & T INPUTS INCORPORATED IN THE PROJECT

As a result of basic and applied research the following technologies are being studied for application in the field.

(i) A new fungi is being studied as a biological control agent.

(ii) Neem oil is being tested as a mosquito and sandfly repellent.

(iii) Biolarvicides (Bt and Bs) are being field tested for the control of mosquito breeding.

(iv) Insecticide impregnated curtains are being tested in the field.

9. SPECIFIC EFFORTS FOR PRODUCTION/LARGE SCALE USES/ REPLICATION/ HORIZONTAL TRANSFER OF TECHNOLOGY

(i) Civil engineers, architects, town planners and health administrators are being trained by organising 3 to 5 day workshops all over the country (See Annexure - 1).

(ii) Video films in malaria, vector control, and biology of malaria vectors have been produced, these are being telecasted by Doordarshan, Delhi.

(iii) Bioenvironmental control of malaria is being introduced in Kolar district, Karnataka state.

(iv) Additional health education material viz., charts and pamphlets etc., have been prepared for increasing awareness in the communities.

(v) Neem based products are being processed for commercialization.

10. OVERALL ASSESSMENT OF THE PROJECT STATUS IN DEC, 1993

In terms of objective (i)

1. Kheda district, Gujarat: Monitoring of the malariogenic potential created by Narmada project is in progress.

2. Shahjahanpur district, U.P.: *P. falciparum* resistance is being monitored. Biolarvicides are being tested in the control of (i) malaria and (ii) filariasis.

3. Hardwar district (BHEL+IDPL), U.P.: Field trials with biolarvicides in malaria control and repellent action of neem oil have been completed. Studies on the residue analysis of chlorinated hydrocarbon insecticides are in progress.

4. Haldwani, Nainital district, U.P.: A one year study on rice fields has been completed.

5. Allahabad district, U.P.: Migration in quarry areas is under investigation with particular reference to *P. falciparum*.

6. Mandla district, M.P.: Studies on pyrethroid impregnated curtains are in progress. Hospital based studies on pregnancy and malaria and deaths due to cerebral malaria have been completed.

7. Rourkela, Sundargarh district, Orissa: Insecticide impregnated bednets have successfully controlled malaria in the mining areas, studies on rice fields are in progress. Biolarvicides successfully controlled mosquito breeding.

8. Goa, Panjim district, Panaji: Malaria in Panjim has been successfully controlled and transmission is mainly confined to the construction sites. Biolarvicides were tested in the control of malaria and filaria with good results.

9. Kamrup district, Assam: The strategy of impregnated bednets is being propagated in the NE states. Management of serious and complicated malaria have been organized in the tea gardens.

10. Car Nicobar, A & N islands: One way sluice gates have controlled An. sundaicus breeding in the island, biolarvicides successfully controlled the breeding of An. sundaicus.

11. Madras, T.N.: 7-point action plan for the control of malaria in Madras has been implemented. An. stephensi breeding in the experimental areas comprising of 3 corporation divisions was totally under control (90,000 population). Bye-laws are being amended.

12. Delhi, U.T.: Larvivorous fishes are being mass produced at the Seelampur farm. Remote sensing and geographical information system studies have been taken up. MRC is implementing the action plan with the state health department.

13. MRC Hqs, Delhi: All support activities related to the S&T project have functioned extremely well. The main activities are (i) preparation of health education material (ii) video films (iii) training programme for engineers (iv) organising review meetings, visits etc. (v) publications (vi) handling of administrative and financial matters.

In terms of objective (ii)

Development of a cost-effective model for extension and/or duplication in similar other geographical areas of the country.

Studies on the industrial malaria control revealed that the strategy is highly cost effective. Experimental areas are being expanded eg., entire Madras city and Karnataka state have been taken up for the bioenvironmental malaria control. Cost effectiveness studies on biolarvicides showed that they are almost equal or slightly expensive compared to larvicidal oil and expensive in comparison to Baytex and Fenthion.

In terms of Additional objectives

The strategy has been adopted in Karnataka. It is being extended to cover the entire state of Goa and Madras city is being taken up as a whole for malaria control.

11. B.E. 1993-94, R.E. 1993-94 AND THE ACTUAL EXPENDITURE

1993-94 (Rs in lakhs)

B.E.	450.00
R.E.	255.00
Actual expenditure	255.00 (Till Mar'94)

(See page 2)

12. PERFORMANCE

12.1 MRC HQs, DELHI

The following activities were carried out at the MRC HQs office.

(i) Central facility for data collection, analysis and retrieval.

(ii) Research support. Studies were done on (i) neem oil, (ii) laboratory and field evaluation of biolarvicides, and (iii) planning of field work.

(iii) Transfer of technology is being done in Karnataka, Madras and Goa.

(iv) Preparation of exhibitions, folders, and video films.

(v) Organizing project committee meetings.

(vi) Organizing visits of important scientists to the field stations.

(vii) Independent cross-checking of field activities and providing direction and mid-course correction.

(viii) Coordination and interface with different agencies.

(ix) Special studies in certain areas such as relapse pattern in P. vivax, drug resistance, migration, economic loss due to malaria, socio-logical studies and impact of health education etc.

(x) Fixing targets for each activity of the field stations.

(xi) Research publications, communications, and writing reports etc.

(xii) Recruitment, site selection and arranging major equipments etc.

(xiii) Organizing training courses : (i) training for the MRC staff on various subjects and (ii) training of engineers and architects.

12.2 WORK DONE IN FIELD STATIONS

(I) HARDWAR DISTRICT, U.P.

The field station is presently engaged in two major research projects viz; i) Determination of levels of antimalarials in malaria cases and ii) Levels of chlorinated pesticides in different components of the ecosystem besides bioenvironmental control of industrial malaria project. Suitable HPLC methods have been developed for the determination of sulfadoxine and sulfalene in plasma, whole blood and red blood cells and the method applied to find out their concentrations in P. falciparum infected cases after giving standard treatment with Fansidar or Metakelfin. A filter paper method for the determination of HCH and DDT residues in whole blood has been developed using finger prick whole blood dried on filter paper. The method was used for monitoring HCH and DDT levels in the blood of the i) occupationally exposed persons (spraymen) and ii) from general population. Bioenvironmental control of industrial malaria at BHEL, Hardwar and IDPL, Rishikesh were under maintenance phase and the implementation of bioenvironmental control strategy at IOC Mathura was in the second year of its full operation. The field station has received request from IOC Baroda and NTPC Shaktinagar to survey the malariogenic potential of these complexes. Large-scale field trials of biocides in river bed pools and factory scraps are in progress and producing good results to control mosquito breeding in these habitats.

Determination of levels of antimalarials in malaria cases

Sulfadoxine: A reverse phase HPLC method has been developed for the separation of sulfadoxine from other antimalarials using acetonitrile-methanol-perchloric acid (1M) - water in the proportion of (30:9:0.8:95, v/v) at a flow rate of 1.5 ml/min on u Bondapak C_{18} reverse phase column (3.9 x 300 mm, particle size, 10 µm) with UV detection at 254 nm. The method was applied to determine sulfadoxine concentrations in plasma, red blood cells and whole blood of 3 healthy volunteers and 50 P. falciparum malaria cases (Table 1).

Caliberation curves were linear in the range 0.5 - 100 µg/ml and correlation coefficients were above 0.99. The mean percentage recovery from plasma, red blood cells and whole 4 blood was 90.28, 92.05 and 94.69 respectively. The N - acetyl metabolite and pyrimethamine could not be detected due to poor recoveries. Within day and day-to-day coefficient of variation averaged to 2.10 and 6.45% respectively. Accuracy ranged between 10.63 to 8.53%.

TABLE 1: HARDWAR: MEAN SULFADOXINE CONCENTRATION IN PLASMA, WHOLE BLOOD AND RED BLOOD CELLS OF HEALTHY AND P. falciparum MALARIA PATIENTS AFTER ADMINISTRATION OF TWO TABLETS OF FANSIDAR

	CONCENTRATION (mean ± S.D., µg/ml)					
	DAY 2		DAY 7		DAY 15	
	Healthy[a]	Malaria[b]	Healthy[a]	Malaria[b]	Healthy[a]	Malaria[b]
Plasma	70.86 ± 13.55	107.52 ± 15.14	45.34 ± 12.67	75.41 ± 14.24	34. 4 ± 7.04	39.79 ± 7.72
Whole blood	53.86 ± 5.90	67.72 ± 11.82	33.32 ± 9.57	43.83 ± 8.77	26.82 ± 5.26	24.7 ± 4.46
Red blood cells	12.79 ± 3.13	11.86 ± 3.66	7.45 ± 2.64	7.00 ± 1.94	5.20 ± 2.65	4.16 ± 1.37
WB/Plasma	0.76	0.63	0.73	0.58	0.77	0.62
RBC/Plasma	0.18	0.11	0.16	0.09	0.15	0.10

a - Average of 3 healthy volunteers; b - Average of 50 P. falciparum malaria patients

Mean sulfadoxine concentrations in 3 healthy volunteers on D2, D7 and D15 after the intake of two tablets of Fansidar were 70.86, 45.34 and 34.40 µg/ml in plasma; 53.86, 33.32 and 26.82 µg/ml in whole blood and 12.79, 7.45 and 5.20 µg/ml in red blood cells respectively while the mean sulfadoxine concentrations in 50 P. falciparum malaria patients on D2, D7 and D15 were 107.52, 75.41 and 39.79 µg/ml in plasma; 67.72, 43.83 and 24.70 µg/ml in whole blood and 11.86, 7.00 and 4.16 µg/ml in red blood cells respectively.

The mean sulfadoxine concentrations were higher in plasma than whole blood or red blood cells in healthy as well as in P. falciparum malaria cases. The inter-individual variations for sulfadoxine in different blood components were between 2 - 3 folds. A comparison of mean sulfadoxine concentrations in healthy and P. falciparum malaria cases shows that the mean sulfadoxine concentrations in plasma and whole blood of P. falciparum cases were higher than healthy volunteers while red blood cells concentration were similar in both the cases.

The mean sulfadoxine concentration ratios of whole blood to plasma in healthy cases on D2, D7 and D15 were 0.76, 0.73 and 0.77 while in P. falciparum malaria cases were 0.63, 0.58 and 0.62 respectively. The mean sulfadoxine concentration ratios of red blood cells to plasma on D2, D7 and D15 were 0.11, 0.09 and 0.10.

Sulfalene: A normal phase HPLC method using dichloromethane methanol - perchloric acid (1M) in the proportion of (96:9:1,

TABLE 2: HARDWAR: SULFALENE CONCENTRATION IN PLASMA, WHOLE BLOOD AND RED BLOOD CELLS OF P.falciparum PATIENTS AFTER BEING TREATED WITH TWO TABLETS OF METAKELFIN

	Concentration[a] (Mean ± S.D.) (µg/ml)		
	Day 2	Day 7	Day 15
Plasma	44.58 ± 12.06 (22.95 - 69.15)	14.90 ± 3.89 (7.95 - 23.32)	1.70 ± 0.62 (0.90 - 2.92)
Red blood cells	7.77 ± 3.00 (3.75 - 12.97)	3.25 ± 1.25 (1.57 - 5.17)	0.28 ± 0.10 (0.135 - 0.45)
Whole blood	25.00 ± 7.27 (11.92 - 36.90)	7.51 ± 1.94 3.82 - 11.55)	0.95 ± 0.28 (0.375 - 1.425)

a - Concentrations are an average of 50 P. falciparum patients; Concentration range is in parentheses

v/v) as mobile phase at a flow rate of 1ml/min on Nucleosil 100-7 (250 x 8 x 4 mm, particle size 7 um) normal phase column with UV detection (254 nm) has been developed for the separation of sulfalene from other antimalarials and baseline separation was achieved between pyrimethamine, sulfadoxine, sulfalene and sulfamethoxazole. The method was applied to determine sulfalene concentrations in 50 P. falciparum malaria cases (Table 2).

Caliberation curves were linear in the range 0.5 - 100 µg/ml and correlation coefficients were above 0.99. The mean percentage recovery of sulfalene from plasma, red blood cells and whole blood was 82, 82.4 and 82.6 respectively. Within day and day-to-day coefficient of variation averaged 3.1 and 7.1% respectively. The percentage accuracy ranged between - 3.98 to 6.35. Mean concentrations of sulfalene in 50 P. falciparum malaria cases on D2, D7 and D15 after administration of two tablets of Metakelfin were 44.58, 14.90 and 1.70 µg/ml in plasma; 7.77, 3.25 and 0.28 µg/ml in red blood cells and 25.00, 7.51 and 0.95 µg/ml in whole blood respectively.

The mean sulfalene concentrations were higher in plasma than whole blood or red blood cells. The mean sulfalene concentration ratios of whole blood of P. falciparum cases on D2, D7 and D15 were 0.56, 0.50 and 0.55 respectively. The ratio remained stable from D1 to D15.

Levels of chlorinated pesticides in different components of the ecosystem

A method for the determination of HCH and DDT residues in whole blood has been developed, using finger prick whole blood dried on filter paper. This method was applied to find HCH and DDT residual level in whole blood from 47 occupationally exposed persons (i.e. persons involved in the spraying of HCH and DDT) and 37 samples from general population.

Whole blood samples (100µl) were collected through finger prick with the help of heparinized capillary tubes filled up to the red mark from 47 occupationally exposed group and 37 from general population during Ardh Kumbh congregation held at Hardwar, U.P., India. The filter papers were dried in hanging position and protected from the insects. After drying, each filter paper was placed between plain paper and kept at ambient temperature. Proper care was taken to avoid cross contamination during the Packing.

The dried blood spots on the filter paper were cut into small pieces and immersed into 5 ml of n-Hexane : Acetone (1:1 v/v) for 20 minutes and vortexed for 10 minutes. Solvent phase was separated. The filter paper was re-extracted twice with

TABLE 3: HARDWAR: RESIDUAL CONCENTRATIONS OF HCH AND DDT IN WHOLE BLOOD

Population		HCH Concentration					DDT Concentration				
		α-HCH	β-HCH	γ-HCH	δ-HCH	TOTAL	o-p	p-p	o-p	p-p	Total
Occupationally exposed (n-47)	Mean+S.E.	24.05+1.92	33.08+3.42	8.50+2.25	2.37+0.99	68.01+4.98	3.28+1.54	44.42+7.33	1.48+0.68	9.24+3.31	58.43+8.20
	-	-	-	-	-	-	-	-	-	-	-
	Range	7.81-75.58	9.89-156.3	ND-61.67	ND-34.09	33.43-231.8	ND-44.45	ND-211.60	ND-20.09	ND-95.24	11.18-238.31
General population(n-37)	Mean+S.E.	6.32+0.62	13.44+0.82	1.75+0.49	ND	21.50+1.27	4.67+1.24	16.13+2.3	ND	ND	20.79+2.43
	-	-	-	-		-	-	-			-
	Range	1.76-16.75	4.87-23.80	ND-12.15	-	8.36-33.17	ND-25.15	ND-69.41	-	-	ND-69.41

* : Concentrations in µg/l; ND : Not detectable

5 ml of n-hexane : acetone mixture. The extracted solvent was pooled and evaporated to 2 - 5 ml on Vortex evaporator. The concentrated samples were cleaned up by passing through sodium sulphate - silica column using n-Hexane : benzene (50:50 v/v) as eluting solvent. The elute was collected and dried. The dried samples were dissolved in n-hexane before gas chromatographic analysis.

Concentrations of the samples stored upto one month did not differ from each other.[7] Concentrations of DDT and HCH in whole blood taken by finger prick and venous punctures at the same time were found similar (n=7). Average HCH and DDT levels in whole blood determined by filter paper method from 37 male which were not involved in spraying operation (age group 20 - 50 years, average weight 47 kg) from District Hardwar, U.P. are given in Table - 3. Mean HCH and DDT contents in general population were 21.50 µg/L (range 8.36 - 33.17 µg/L) and 20.79 µg/L (range ND-69.41 µg/L) respectively. HCH contributed 62.5% followed by HCH 29.4% and HCH 8.1% of the total HCH present. Similarly p-p DDE was 77.6% followed by o-p DDE 22.4% of DDT. No p-p DDT was detected in any of the samples.

Results of 47 samples from the occupationally exposed persons who were involved in the spraying operation of HCH and DDT during Ardh Kumbh Congregation at Hardwar are given in Table 3. Mean HCH concentration in whole blood was 68.0 µg/L (range 33.43 - 231.8 µg/L) while mean DDT was 58.43 µg/L (range 11.18 - 238.3 µg/L). β-HCH contributed 48.6% followed by α, γ and δ of 35.4%, 12.5% and 3.5% respectively of the total HCH. Similarly p-p DDE contributed 76 % followed by p-p DDT 15.8 %, o-p DDE 5.6 % and o-p DDT 2.5% of total DDT found.

A comparison of the levels of HCH and DDT in occupationally exposed and general population is given in Fig. 1. It is clear that the level of HCH in blood from occupationally exposed population was 3.5 times more as compared to general population. Similarly, DDT level was 2.5 times more in exposed group as compared to general population. Comparatively, higher concentrations of p-p DDT and γ - HCH in exposed cases resulted due to recent exposure by spraying operations.

Statistical comparison of the residual level of HCH in whole blood from two different group of population i.e. occupationally exposed and general population showed the significant difference ($p < 0.001$). Significant difference was also observed for DDT residues in blood from two group populations ($p < 0.001$).

Bioenvironmental control of industrial malaria

BHEL, Hardwar: The area is without regular intervention activities for the last two years, but breeding source surveys

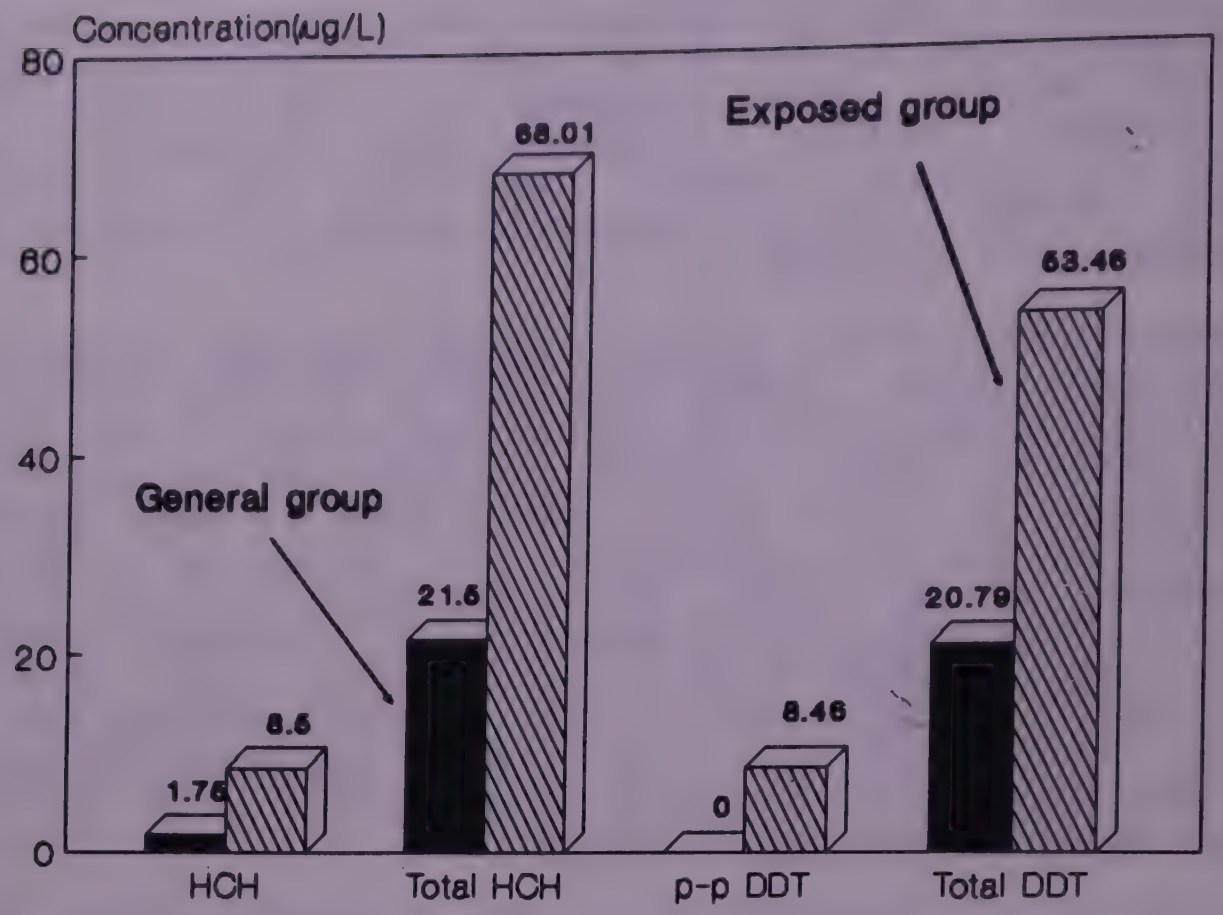


Fig. 1: Hardwar: Comparison of HCH and DDT residues in whole blood from general and occupationally exposed population

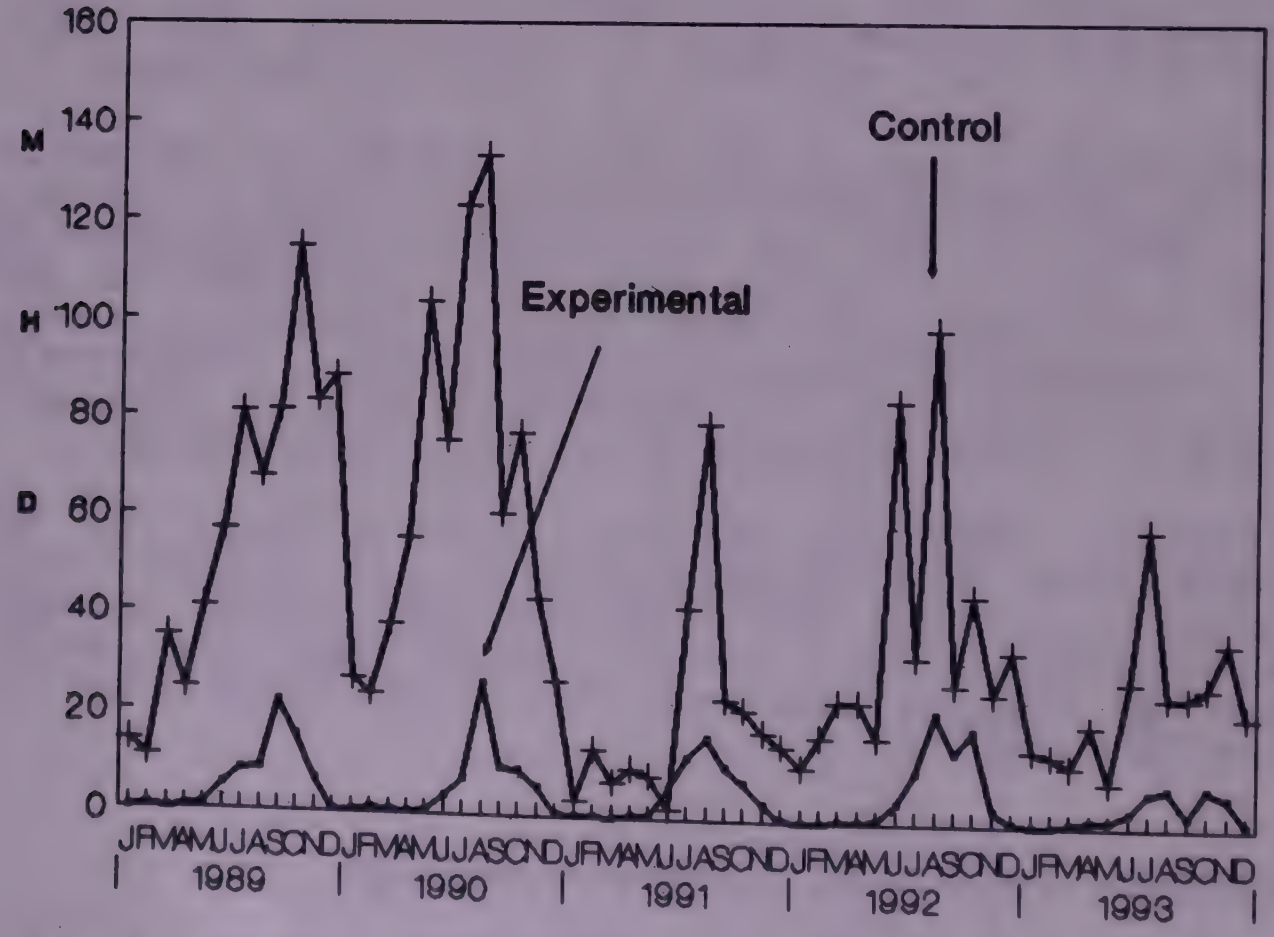


Fig. 2: Hardwar: Vector density in Experimental and Control

were being carried out to monitor re-occurrence of any temporary breeding place within the complex. Adult mosquito density was monitored in experimental and control areas at fortnightly interval. Fig. 2 shows that vector density was maintained at low-level in the experimental area as compared to control area since implementation of bioenvironmental control strategy during 1986. This has been responsible for remarkably reducing malaria transmission in over the complex. More than 90% of the total density of An. culicifacies in the township was contributed by seasonal river Ranirao during monsoon where bioenvironmental control strategy had limited role to play.

About 10 lakh larvivorous fishes viz; guppy and Gambusia are being maintained in eight fish hatcheries at BHEL campus. These fishes provide excellent mosquito breeding control in all permanent water bodies such as storm water drains, effluent ponds, ornamental tanks and underground tanks.

Results of active and passive surveillance for 1993 are given in Table 4. During 1993 there were only 93 total malaria cases with a slide positivity rate (SPR) of 2.80% as compared to 121 cases during 1992 and steady decline was observed since its implementation (Fig. 3). Only 7 P. falciparum cases were reported this year and all were imported.

Follow-up of 1981 malaria cases from January. 1988 to December 1993 revealed that about 30% of the cases were from Jwalapur and adjoining areas and 12% were imported from other parts of the country.

TABLE 4: HARDWAR (BHEL): PARASITOLOGICAL DATA (1993)

Month	Total B/S collected	Pv	Pf	Total +ve	SPR
Jan	103	0	0	0	0.00
Feb	134	1	0	1	0.75
Mar	154	0	0	0	0.00
Apr	257	2	0	2	0.77
May	272	9	0	9	3.30
Jun	343	7	0	7	2.00
Jul	672	23	0	23	3.40
Aug	395	19	1	20	5.10
Sep	361	13	1	14	3.90
Oct	334	6	4	10	3.00
Nov	186	5	1	6	3.22
Dec	130	1	0	1	0.76
Total	3341	86	7	93	2.80

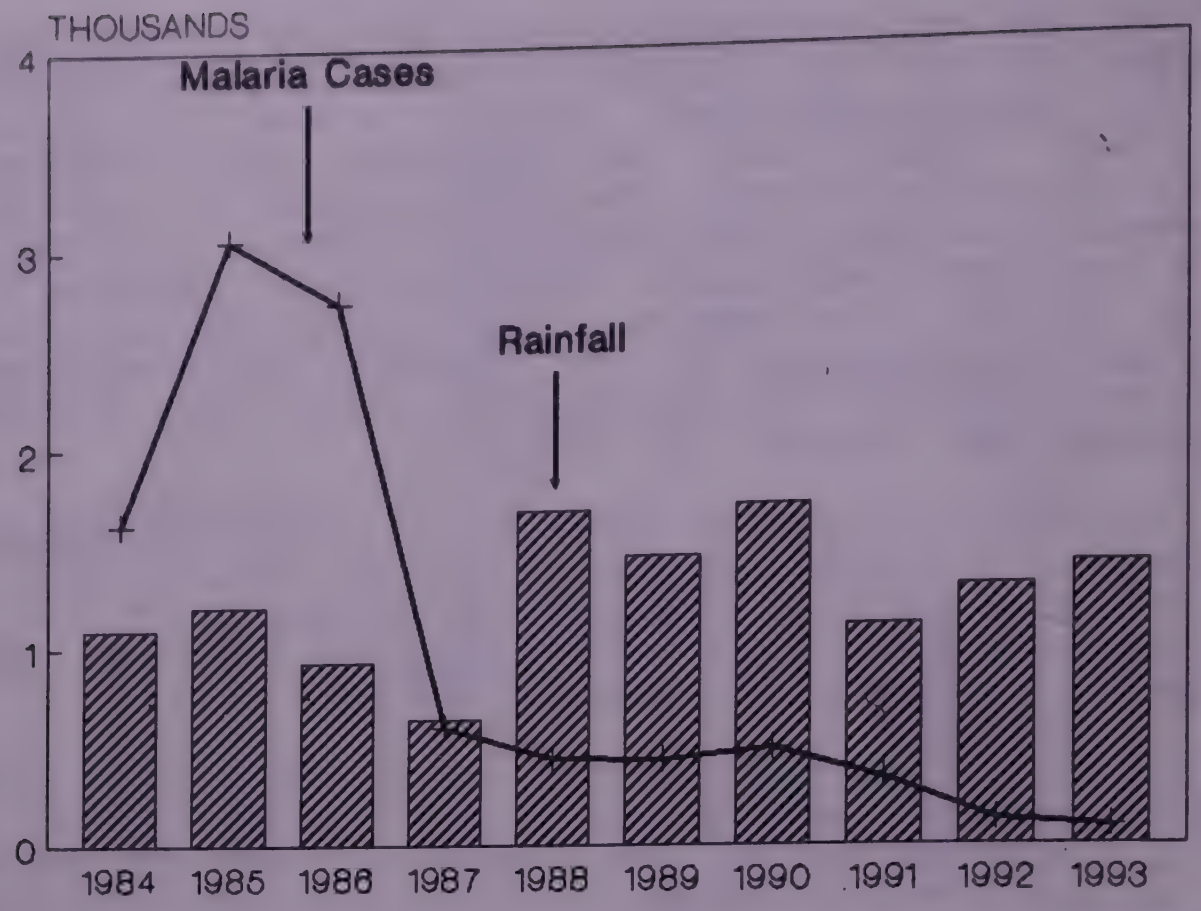


Fig. 3: Hardwar: Rainfall vs Malaria Incidence

IDPL, Rishikesh: Malaria cases reported during 1993 at the Malaria Clinic of MRC at IDPL hospital are given in Table 5. The data shows that there were only 56 total malaria cases and incidence of P. falciparum was nil. Comparison of malaria cases from 1987 to 1993 are given in Table 6 and shows that since 1992

TABLE 5: HARDWAR (IDPL): PARASITOLOGICAL DATA (1993)

Month	Total B/S collected	Pv	Pf	Total +ve	SPR
Jan	61	1	-	1	1.64
Feb	75	-	-	-	0
Mar	129	-	-	-	0
Apr	100	1	-	1	1.00
May	94	6	-	6	6.40
Jun	118	8	-	8	6.80
Jul	135	9	-	9	6.66
Aug	90	7	-	7	7.80
Sep	153	8	-	8	5.20
Oct	112	8	-	8	7.14
Nov	84	5	-	5	5.95
Dec	76	3	-	3	3.95
TOTAL	1227	56	-	56	4.55

TABLE 6: HARDWAR (IDPL): MALARIA CASES (1987-93)

Year	Total +ve	Pf
1987	133	4
1988	133	4
1989	99	2
1990	164	2
1991	124	-
1992	57	-
1993	56	-

very low transmission is going on. It is worth mentioning that this area is without intervention since 1991.

IOC, Mathura: Integrated vector control programme has entered into the second year of operation. During this period breeding source surveys inside Mathura refinery township and peripheral villages were carried out at weekly intervals and positive breeding places were subjected to intervention measures carried out by refinery staff under the supervision of MRC. The main source of breeding of An. culicifacies is river Yamuna besides other permanent water logged areas in the adjoining villages.

Results of monitoring of adult densities in the township and peripheral villages are given in Table 7. Data shows that vector density (An. culicifacies and An. stephensi) is very low in the township area as compared to peripheral villages but man-biting does take place on the campus as observed during whole night human bait collections thereby indicating that An. culicifacies might be infilterating from peripheral villages because of their proximity to township area.

The results of active and passive surveillance are given in Table 8. During 1993 there were 995 total malaria cases with slide positivity rate (SPR) of 15.60%. There was 65% reduction in P. falciparum cases during 1993 (Total Pf - 104) as compared to 1992 (Pf - 297).

Studies on Biolarvicides

Field trials on the efficacy of Bactoculicide (Bacillus thuringiensis H-14) and Spherix (B. sphaericus) were carried out at BHEL in factory scraps and river bed pools in seasonal river Ranirao as well as in Yamuna river bed pools near IOC, Mathura refinery.

TABLE 7: HARDWAR (IOC, MATHURA): DENSITY OF ANOPHELINES AND VECTORS (1993)

Area	MHD	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
IOC,Township	TA	2.5	2.5	3.0	2.0	0.5	4.5	5.0	10.0	11.0	16.0	10.0	9.0
	VD	0.0	0.0	0.0	0.5	0.0	0.0	1.0	2.5	4.0	3.0	2.5	2.0
Peripheral villages	TA	25.3	20.3	38.0	25.5	42.3	30.5	48.5	84.8	75.5	126.3	40.7	30.8
	VD	3.5	3.8	20.5	9.5	10.5	9.5	14.0	23.0	18.5	42.5	7.5	7.0

TA : Total anopheline; VD : Vector density

TABLE 8: HARDWAR (MATHURA REFINERY): PARASITOLOGICAL DATA (1993)

Month	B.S.C	Total +ve	Pv	Pf	SPR
Jan	295	30	11	19	10.20
Feb	136	12	8	4	8.80
Mar	226	18	15	3	8.00
Apr	325	34	25	9	10.50
May	312	59	56	3	18.90
Jun	589	137	136	1	23.25
Jul	960	129	128	1	13.40
Aug	992	133	132	1	13.40
Sep	710	173	171	2	24.40
Oct	1006	170	130	40	16.90
Nov	515	69	49	20	13.40
Dec	326	31	30	1	9.50
Total	6392	995	891	104	15.60

a) **Industrial scraps:** Fig. 4 shows results of application of Bactoculicide in factory scraps such as broken heavy machine parts, discarded drums, scrap iron moulds, old tyre dumps etc. These type of habitats are almost specific to most of the industries and create mosquitogenic conditions because of heavy breeding of Aedes aegypti, Ae. albopictus, culex sp. and some anophelines. Bactoculicide when applied at a dose of 0.5 gm/sq.m produced 90-100% control in the 3rd and 4th instar larvae upto 6th week hence could be a very good biological control agent for application in such problematical habitats.

b) **River bed pools:** River bed pools are the most favoured habitats for the breeding of An. culicifacies. In the absence of any permanent solution for riverine breeding, bio-larvicide viz; Spherix was evaluated for its efficacy in such habitats. Spherix when applied at the dose of 1.0 gm/sq.m. in river bed pools at seasonal river Ranirao produced only 45 to 52% mortality in the IIIrd and IVth instar larvae of An. culicifacies upto 2 weeks. However, subsequent re-application after 2nd and 4th week resulted in higher mortality ranging from 75 to 98% (Fig 5). The same biocides when applied at the same dosage in river bed pools in Jamna river produced 92% mortality upto 2 weeks (Fig. 6). Therefore, if suggests that efficacy of biocide may be affected because micro-climatic conditions.

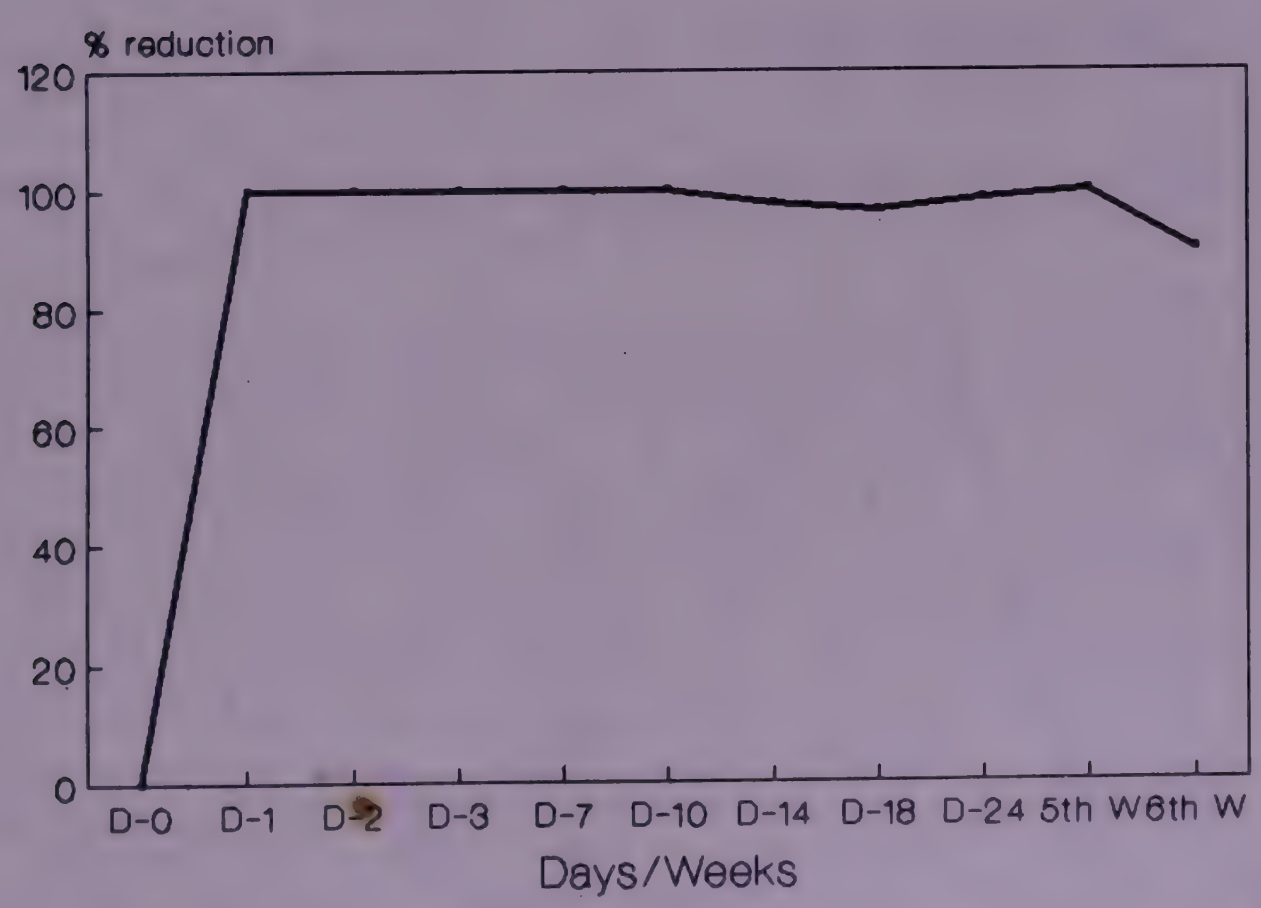


Fig. 4: Hardwar (BHEL): Effect of Bactoculicide in factory scraps

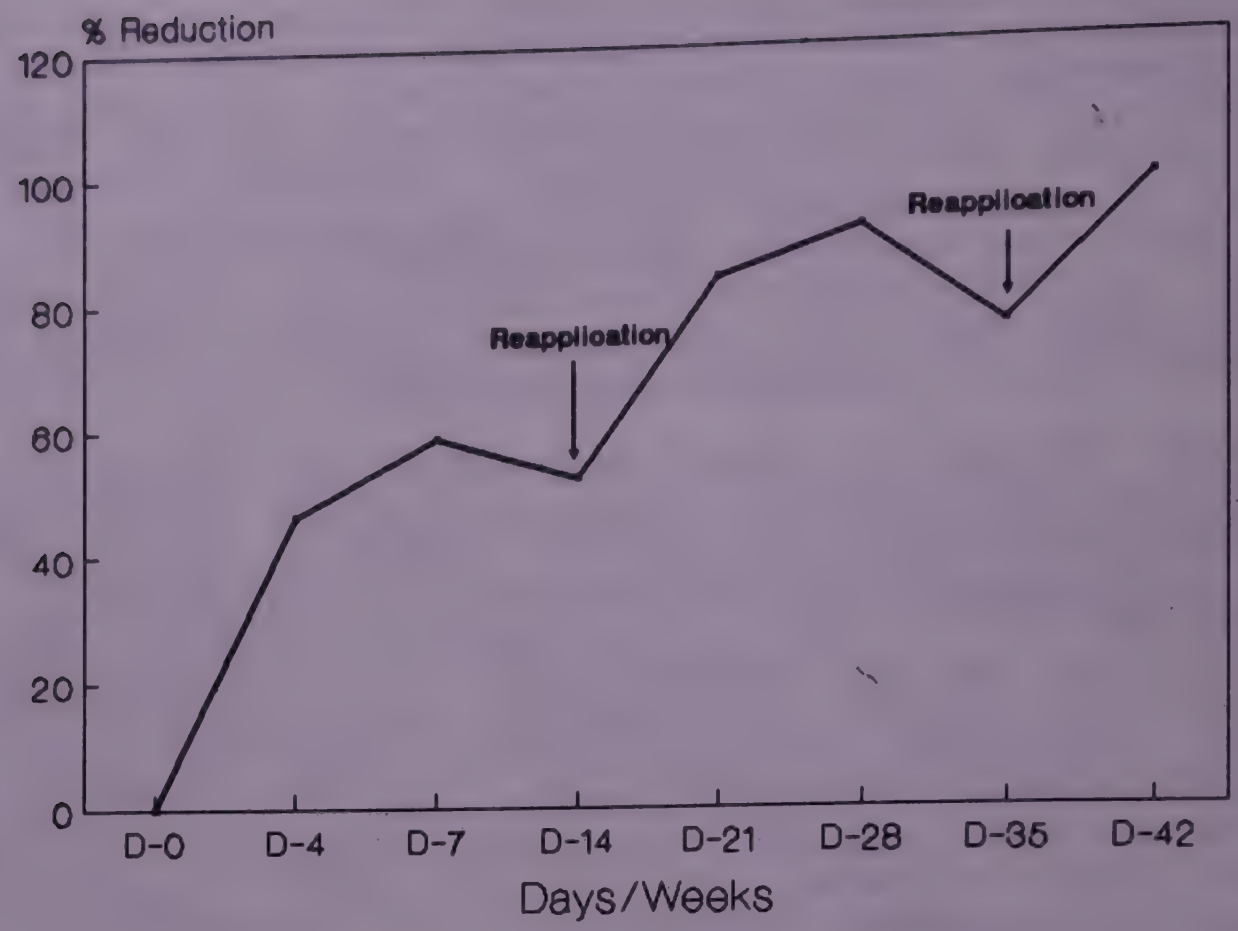


Fig. 5: Hardwar (BHEL): Field evaluation of Spherix in river bed pools (Ranirao)

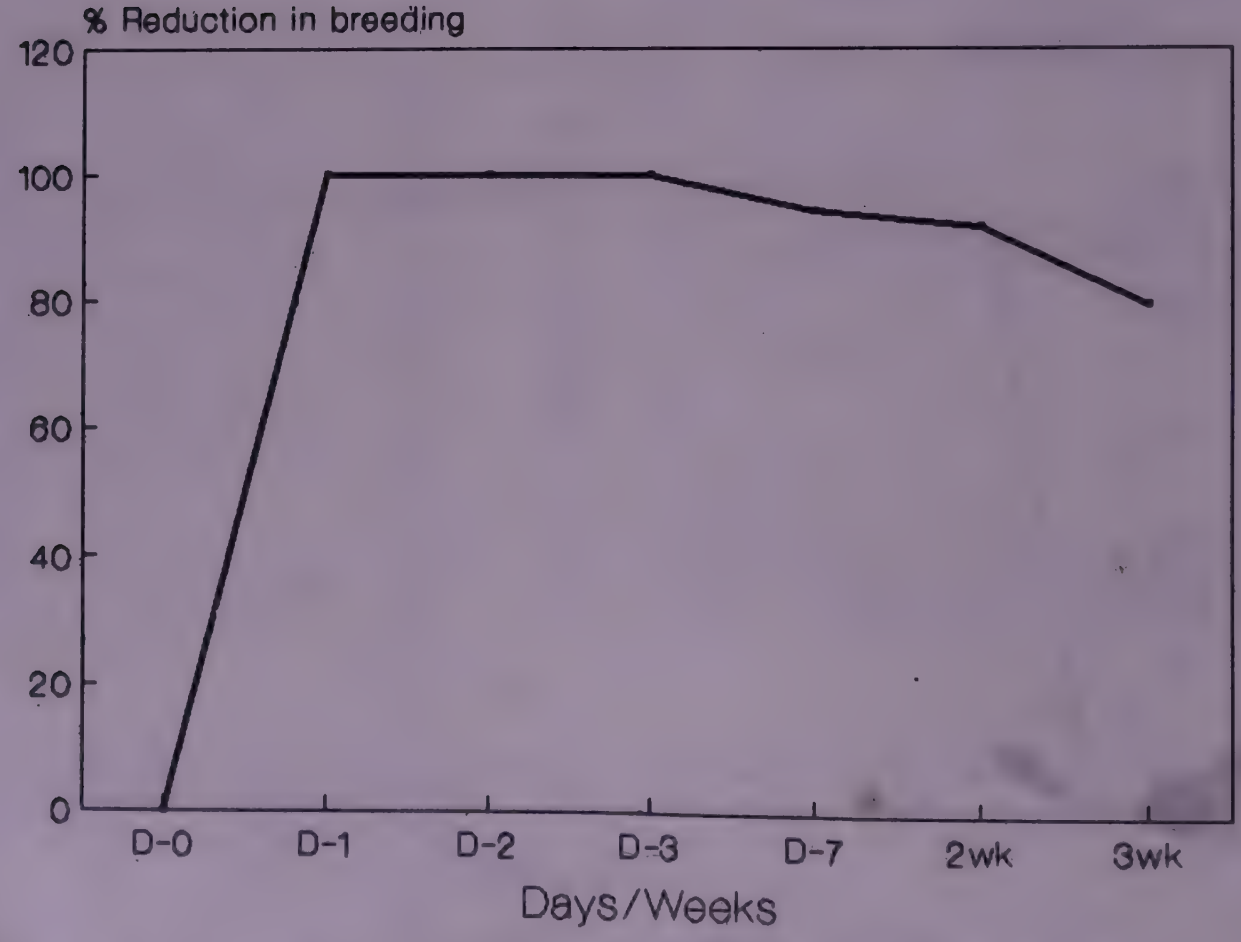


Fig. 6: Hardwar (Mathura): Field evaluation of Spherix in Yamuna river bed pools

(II) HALDWANI, NAINITAL, U.P.

Riceland agro-ecosystem in transmission dynamics of malaria

Studies on riceland agro-ecosystem in transmission dynamics of malaria in collaboration with G.B. Pant University of Agriculture and Technology, Pantnagar were continued during 1993 in two areas i.e., terai and bhabar. Observations were recorded on the seasonal changes in larval population in paddy fields and peridomestic sites, propagation of vector population, natural parasitic infection with Coelomomyces and malaria incidence. Paddy crop is cultivated annually during June to October (wet cropping season) but in some parts of terai where plenty of water is available, second crop is also cultivated during March to June (dry cropping season). A total of 36 paddy plots with 7 varieties and fertilizers combination were selected for the study.

Entomological investigations: In selected villages of terai and bhabar area, larval and adult densities were regularly monitored on fortnightly intervals. Immature density per dip was recorded from peridomestic sites and paddy fields. In terai during dry cropping season immature anopheline density was low (0.1) during two weeks post-paddy transplantation and high (2.4) for four weeks post-transplantation in the month of April. In wet cropping season anopheline larval density was found to be high during early phase of paddy transplantation in the month of July in (terai 1.3 and bhabar 7.5) and during rest of the months low with not much variation density was noted. The average anopheline density was two times higher in dry as compared to the wet season and culicine density in terai was higher than in bhabar, which might be due to high organic content of soil and more use of fertilizers (Table 1).

Immature density per dip in peridomestic sites is shown in Fig.1, which revealed that anopheline density in terai area was higher than bhabar in general. In bhabar area high density was observed from May to November with peak density in October (2.9). In terai, high anopheline larval density was observed from April to June and in August and peak density was recorded in the month of May (8.3). Density was low during winter months. Anopheline density from peridomestic sites and paddy fields during both cropping periods revealed that density in paddy fields of bhabar area was seven folds higher than peridomestic sites in the month of July. In terai area, nearly equal density i.e. 2.4 in both paddy fields and peridomestic sites was recorded in the month of April, whereas three folds higher density in wet season (July) was recorded than in peridomestic site. In rest of the months its density was low in paddy fields during both seasons as compared to peridomestic site (Table 1 and Fig. 1).

TABLE 1: HALDWANI: DENSITY OF IMMATURES MOSQUITO IN PADDY FIELDS

Area	Cropping season	Months 1993	Larvae per dip		
			Anophelines	Culicines	Total mosquito larvae
Bhabar	Wet cropping season	Jul	7.5	1.7	9.2
		Aug	0.8	1.1	1.9
		Sep	0.3	0	0.3
		Oct	0.8	0.7	1.5
Terai	Dry cropping season	Mar	0.1	0.1	0.2
		Apr	2.4	1.6	4.0
		May	1.3	2.5	3.8
		Jun	0.6	0.6	1.2
	Wet cropping season	Jul	1.3	2.5	3.8
		Aug	0.6	2.7	3.3
		Sep	0.4	0.4	0.8
		Oct	0.5	1.1	1.6

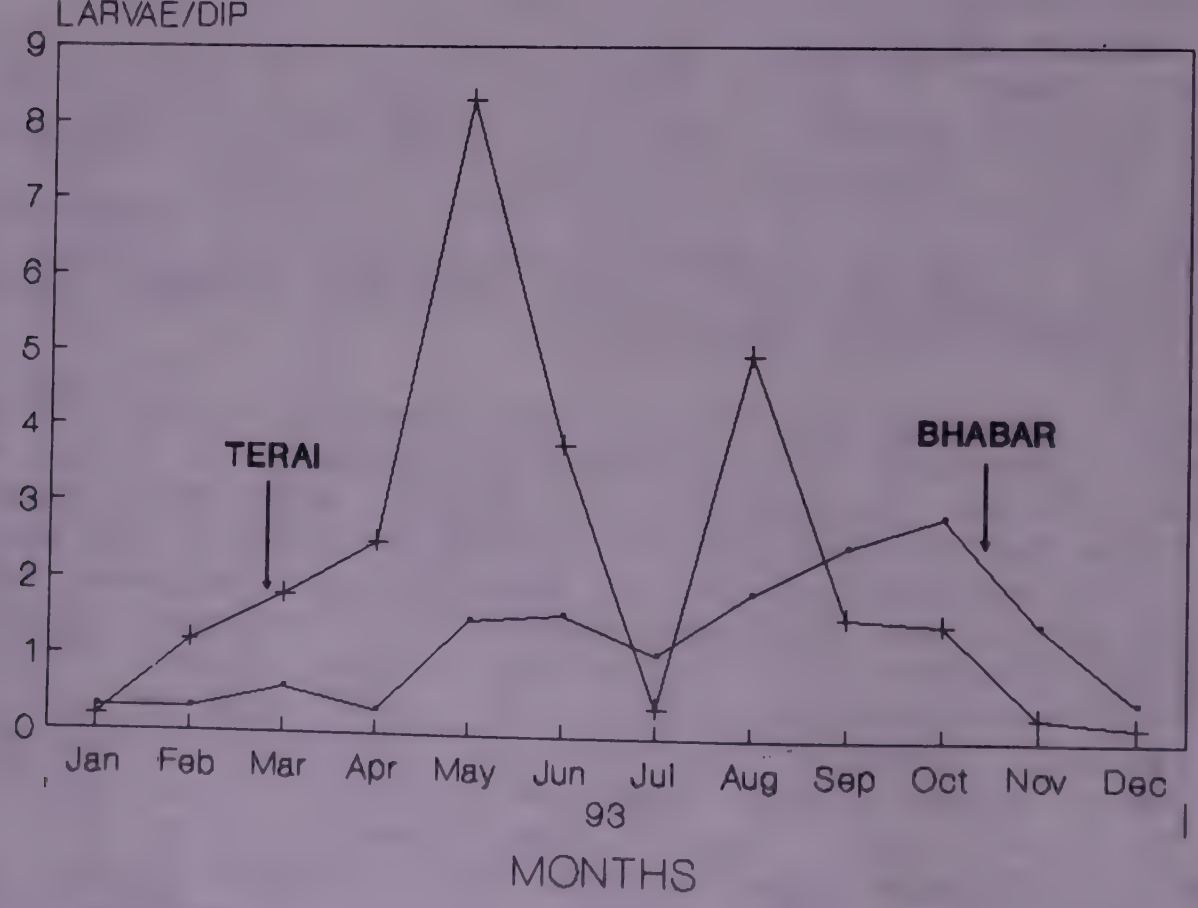


Fig. 1: Haldwani: Density of immatures Anopheline in peri-domestic sites

Monthwise species succession in paddy fields are shown in Table 2. In paddy fields, distribution pattern of anopheline species in both the areas was similar. High prevalence of An. culicifacies was observed during early phase of paddy cultivation up to two month post-transplantation period. Thereafter, density gradually declined to zero. In wet cropping season, high prevalence of An. culicifacies was observed in the month of July in both bhabar (64.6%) and terai (34.5%) areas whereas An. fluviatilis breeding was observed in the month of August and September. It was thus noted that in the early period of paddy transplantation An. culicifacies and An. subpictus were the predominant species in both the areas but in later months, breeding composition shifted to An. nigerrimus. An. nigerrimus, An. fluviatilis and An. annularis were same as observed in wet cropping season. An. subpictus which was predominant in wet season was not observed in dry cropping season. It thus reflects that breeding of anophelines in paddy fields is also dependent upon plant height and season.

Per cent species composition of anophelines in peridomestic sites revealed prevalence of An. culicifacies throughout the year and high composition was recorded between March to August (42.6 to 93.0) in bhabar area (Table 3) whereas in terai its composition was high during May to July (56.7 to 81.5) (Table 4). In bhabar area An. fluviatilis breeding was restricted to winter months only, while in terai its prevalence was high during early winter and summer months. An. subpictus breeding was not recorded in dry cropping period in peridomestic sites also. Between two breeding grounds per cent prevalence of vector anophelines were recorded more in peridomestic sites than in paddy fields (Tables 3 and 4).

Per man hour densities of vectors and total anophelines were high throughout the year in terai except in August. An. culicifacies density in bhabar was highest in August (39.0) and in rest of the months very low varying from 0 to 5, whereas in terai its prevalence was observed throughout the year and density was high in April (25.4) (Fig.2). An. fluviatilis density in terai was high during late summer and rainy season and two peaks were observed in the months of March (16.8) and October (11.5). But in bhabar An. fluviatilis appeared in low densities from September to December with a small peak (1.4) in the month of October and its prevalence during rest of the period was too low (Fig.2). Per room density also revealed a high density of An. culicifacies in bhabar (19.3) than in terai areas (14.3) in the month of August (Fig. 3). An. fluviatilis density was not observed in human dwellings in space spray collection (total catch) in bhabar area and only a few were collected in terai.

Observing the immature prevalence in association with adult vector density, it appears that paddy fields are contributing more of high adult An. culicifacies population in bhabar area in

TABLE 2: HALDWANI: PREVALENCE OF IMMATURE ANOPHELINES IN PADDY FIELDS

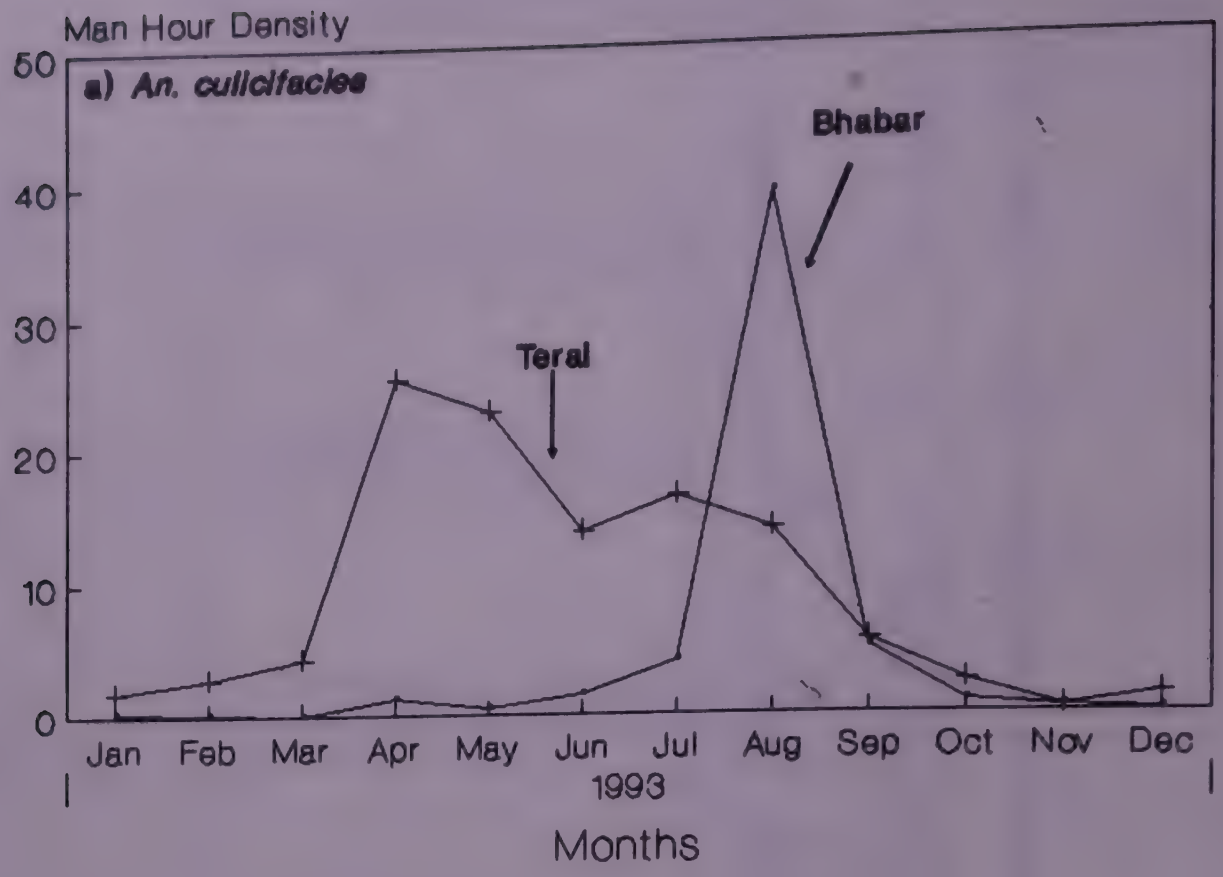
Area	Cropping Season	Months 1993	Total Immature Idenitifed	Percent Species Composition					
				An. culicifacies	An. fluviatilis	An. subpictus	An. annularis	A. nigerrimus	A. barbirotris
BHABAR	Wet cropping season	Jul.	147	64.6	0.0	29.3	6.1	0.0	0.0
		Aug.	166	36.1	0.6	45.8	13.3	4.2	0.0
		Sep.	33	0.0	0.0	18.2	0.0	75.8	6.0
		Oct.	11	0.0	0.0	0.0	0.0	100.0	0.0
TERAI	Dry cropping season	Apr.	138	63.0	0.0	0.0	28.3	8.7	0.0
		May.	158	7.6	1.3	0.0	22.8	68.3	0.0
		Jun.	158	0.0	1.3	0.0	0.0	98.7	0.0
	Wet cropping season	Jul.	200	34.5	0.0	63.0	2.5	0.0	0.0
		Aug.	199	11.6	3.0	63.3	7.0	15.1	0.0
		Sep.	57	7.0	1.8	0.0	0.0	91.2	0.0
		Oct.	26	0.0	0.0	0.0	0.0	100.0	0.0

TABLE 3: HALDWANI: SEASONAL PREVALENCE OF IMMATURE ANOPHELINES IN PERIDOMESTIC SITES IN BHABAR AREA

Months year 1993	Total larvae identified	Per cent species composition							
		An. culicifacies	An. fluviatilis	An. subpictus	An. annularis	An. nigerrimus	An. stephensi	An. gigas	An. barbirostris
Jan	13	0.0	61.5	15.5	0.0	7.7	0.0	15.4	0.0
Feb	20	25.0	0.0	0.0	0.0	35.5	15.0	25.0	0.0
Mar	25	56.0	4.0	0.0	20.0	20.0	0.0	0.0	0.0
Apr	0	-	-	-	-	-	-	-	-
May	57	93.0	0.0	0.0	1.7	18.0	3.5	0.0	0.0
Jun	61	42.6	0.0	54.1	3.3	0.0	0.0	0.0	0.0
Jul	73	76.7	0.0	19.2	4.1	0.0	0.0	0.0	0.0
Aug	43	69.8	0.0	27.9	0.0	2.3	0.0	0.0	0.0
Sep	57	10.5	0.0	75.4	0.0	12.3	0.0	0.0	0.0
Oct	45	20.0	2.2	28.9	33.4	11.1	0.0	0.0	0.0
Nov	26	26.9	23.1	19.3	0.0	3.8	0.0	0.0	0.0
Dec	30	33.3	0.0	13.3	16.7	23.4	0.0	0.0	13.3

TABLE 4: HALDWANI: SEASONAL PREVALENCE OF IMMATURE ANOPHELINES IN PERIDOMESTIC SITES IN TERAI AREA

Months year 1993	Total larvae identified	Per cent species composition							
		An. culicifacies	An. fluviatilis	An. subpictus	An. annularis	An. nigerrimus	An. maculatus	An. stephensi	An. gigas
Jan	21	23.8	0.0	19.1	0.0	19.0	14.3	0.0	23.8
Feb	68	11.8	78.0	0.0	0.0	4.4	0.0	2.9	2.9
Mar	63	3.2	57.1	0.0	1.6	15.9	22.2	0.0	0.0
Apr	25	16.0	0.0	0.0	0.0	20.0	64.0	0.0	0.0
May	108	81.5	3.7	0.0	12.0	0.0	2.8	0.0	0.0
Jun	105	79.0	0.0	5.7	4.8	0.0	0.0	10.5	0.0
Jul	30	56.7	36.7	0.0	0.0	0.0	0.0	6.6	0.0
Aug	69	20.3	0.0	79.7	0.0	0.0	0.0	0.0	0.0
Sep	9	0.0	0.0	66.7	0.0	33.3	0.0	0.0	0.0
Oct	11	54.5	0.0	18.2	0.0	27.3	0.0	0.0	0.0
Nov	17	0.0	59.9	0.0	0.0	41.2	0.0	0.0	0.0
Dec	14	0.0	57.1	0.0	0.0	42.9	0.0	0.0	0.0



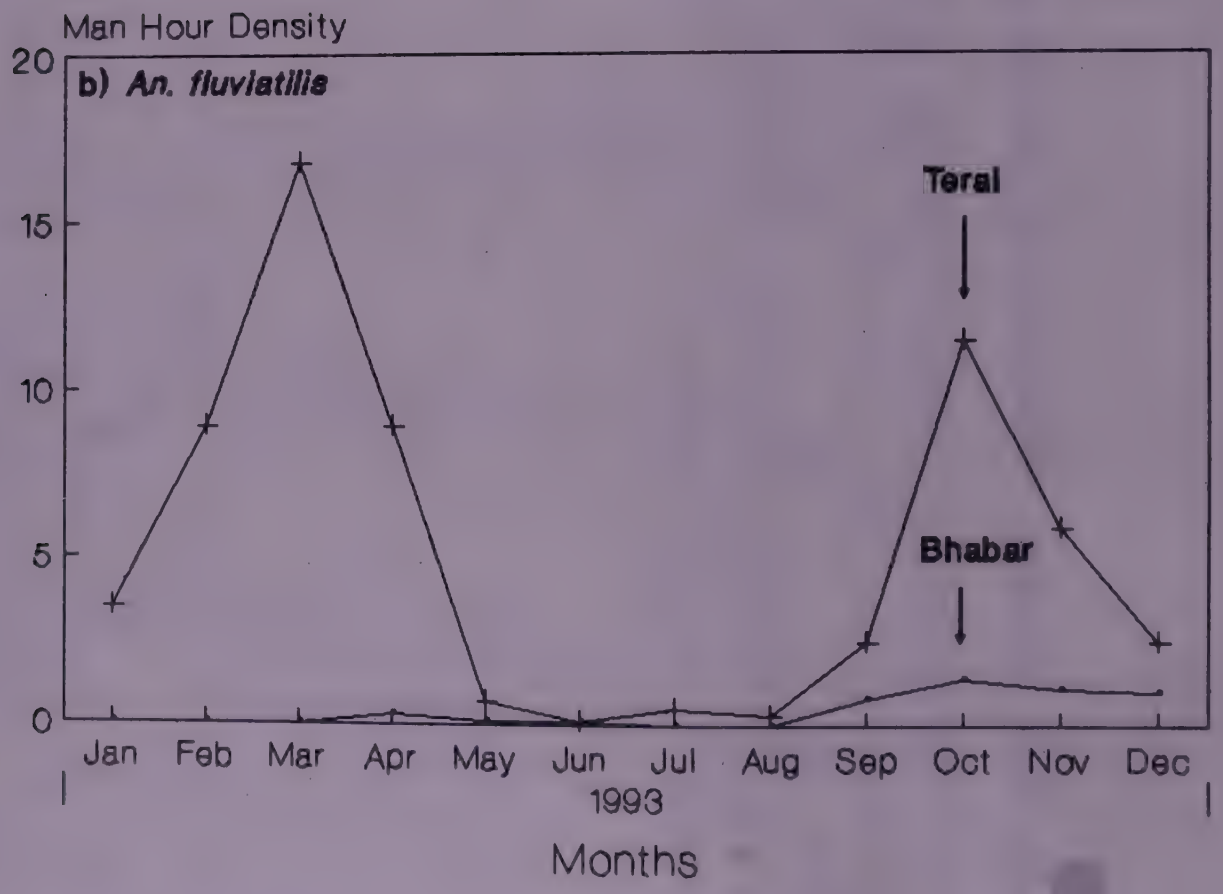


Fig. 2: Haldwani: Density of a) An. culicifacies and b) An. fluviatilis in Terai and Bhabar area

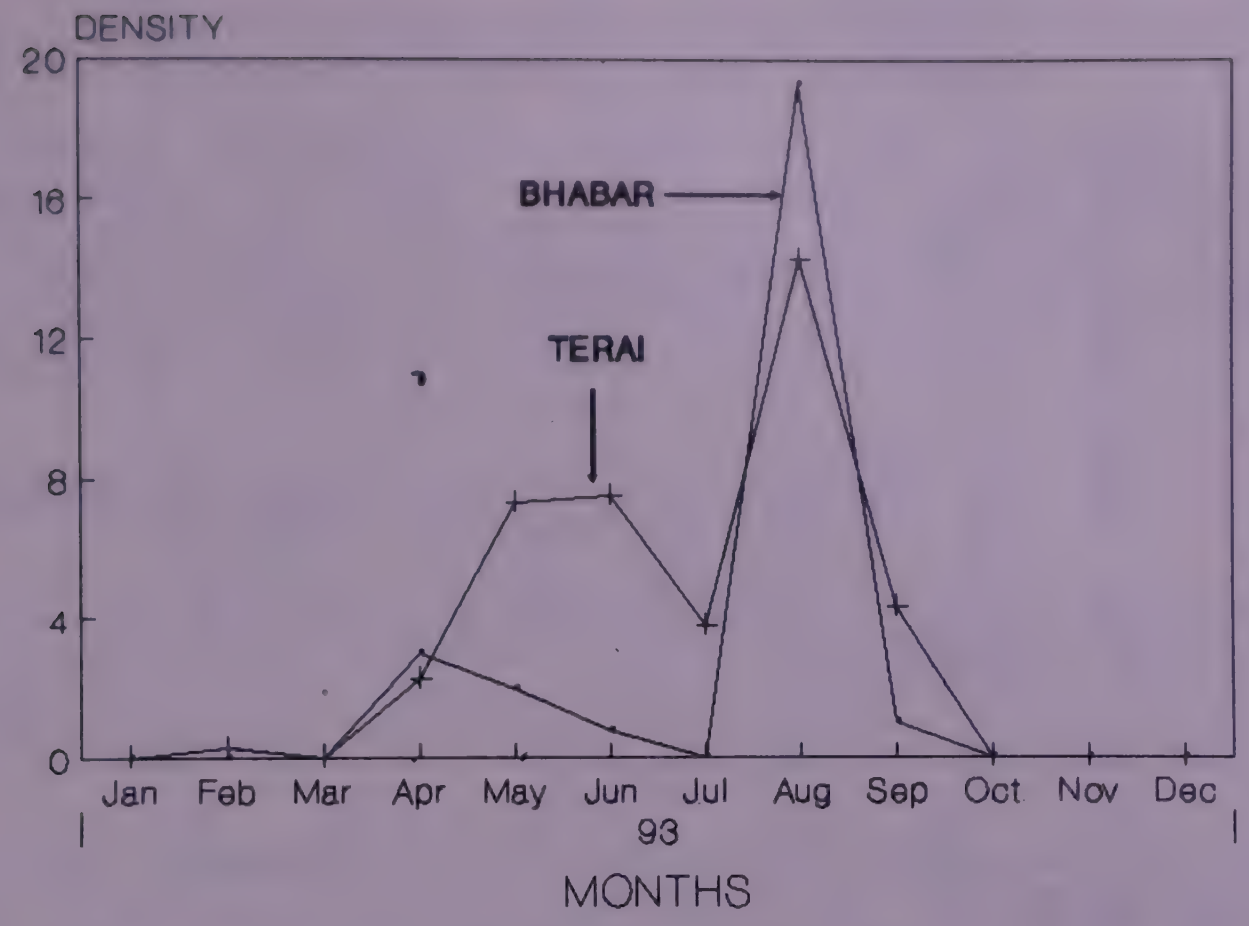


Fig. 3: Haldwani: Per room density of An. culicifacies in Bhabar and Terai area

the month of August. In terai, increase in An. culicifacies density in the month of April and May might be due to paddy transplantation. In both the areas, during paddy cropping season An. culicifacies prevalence increased immediately around two weeks post-transplantation.

Coelomomyces infection : Members of the entomopathogenic fungus belonging to genus Coelomomyces may prove as potential bio-control agent in controlling anopheline population. During our study on association of riceland agro-ecosystem and transmission dynamics of malaria, attempts were made to observe host specificity and seasonal occurrence of Coelomomyces indicus in anopheline larvae in paddy fields and in peridomestic sites. Out of 10 species of immature anopheline prevalent, only three species i.e. An. culicifacies, An. subpictus and An. annularis were found infected with Coelomomyces indicus (Table 5). Between two breeding grounds i.e. paddy fields and peridomestic sites, overall infection rate was six folds higher in paddy fields (3.9) than peridomestic sites (0.7). Comparative analysis of data collected during wet season of paddy cultivation in the two areas revealed that infection was two folds higher in terai than in bhabar. Seasonal occurrence of Coelomomyces indicus revealed high monthly infection rate in the month of July (10.9) and August (8.5) during wet cropping season and low (0.6) in the month of May in dry cropping season and rest of the cultivation period occurrence was nil. Parasitism rate was high in An.

TABLE 5: HALDWANI: COELOMOMYCES INFECTION IN ANOPHELINE LARVAE OF PADDY FIELDS DURING 1993

Area	Season	Months	An. culicifacies	An. fluviatilis	An. subpictus	An. annularis	An. nigerrimus	An. barbirostris	Monthly infection rate
		Jul	74(0)	0	33(0)	8(0)	0	0	0
		Aug	60(6.7)	1(0)	76(10.5)	23(4.5)	7(0)	0	7.8
Bhabar	Wet	Sept	0	0	6(0)	0	25(0)	2(0)	0
		Oct	0	0	0	0	11(0)	0	0
		Subtotal	134(3.0)	1(0)	115(7.0)	30(3.3)	43(0)	2(0)	4.0
		Apr	67(0)	0	0	39(0)	12(0)	0	0
	Dry	May	12(8.3)	2(0)	0	36(0)	108(0)	0	0.6
		Jun	0	2(0)	0	0	156(0)	0	0
		Subtotal	79(1.0)	4(0)	0	75(0)	276(0)	0	0.2
Terai		Jul	61(4.9)	0	90(15.6)	5(0)	0	0	10.9
		Aug	23(17.4)	6(0)	126(10.3)	14(0)	30(0)	0	8.5
	Wet	Sep	4	1(0)	0	0	52(0)	0	0
		Oct	0	0	0	0	26(0)	0	0
		Subtotal	88(8.0)	7(0)	216(12.5)	19(0)	108(0)	0	7.8

Figures in paretheses shows infection rate

subpictus (10.6) followed by An. culicifacies (3.3) and An. annularis (0.8).

Epidemiological investigation: Among the two villages of each bhabar and terai, selected under riceland agro-ecosystem, the weekly surveillance was carried out throughout the year. Monthwise data is shown in Table 6, which revealed low malaria incidence, being limited to two months period i.e., August and September, 1993 in both the areas.

Focal outbreak of malaria in Gadarpur villages

Entomological and epidemiological investigations were carried out in three villages of terai viz. Maseet, Sarovar Nagar and Jhagar Puri to understand the transmission dynamics of malaria during October 93 to January, 1994.

Entomological investigation: A total of five anopheline species viz. An. culicifacies, An. fluviatilis, An. annularis, An. subpictus and An. vagus were collected from human and cattle dwellings from each village by aspirator method. Per man hour density confirmed that An. culicifacies an earlier incriminated vector from this area, is the primary vector present in reasonable density (63.6%). An. fluviatilis density was very low and constituted 8.1% of total anophelines. All the anophelines preferred to rest in cattle sheds while a few An. culicifacies

TABLE 6: HALDWANI: EPIDEMIOLOGICAL DATA OF RICELAND AGROECOSYSTEM VILLAGES

Month Year	Terai Area (Pop. 1238)					Bhabar Area (Pop. 680)				
	BSE	Pv	Pf	SPR	SfR	BSE	Pv	Pf	SPR	SfR
Jan'93	3	-	-	-	-	2	-	-	-	-
Feb	8	1	-	12.5	-	7	-	-	-	-
Mar	10	-	-	-	-	3	-	-	-	-
Apr	8	-	-	-	-	6	-	-	-	-
May	5	-	-	-	-	14	1	-	7.1	-
Jun	17	3	-	17.6	-	6	-	-	-	-
Jul	22	-	-	-	-	18	-	-	-	-
Aug	23	-	1	4.3	4.3	23	2	-	8.6	-
Sep	29	3	-	10.3	-	21	5	-	23.8	-
Oct	4	-	-	-	-	17	-	-	-	-
Nov	1	-	-	-	-	2	-	-	-	-
Dec	8	-	-	-	-	10	-	-	-	-
Total	138	7	1	5.7	0.7	129	8	-	6.2	-

TABLE 7: PER MAN HOUR DENSITY OF ANOPHELINES IN VILLAGES OF GADARPUR

Village	Months	An. culicifacies		An. fluviatilis		An. annularis		An. subpictus		An. vagus		Total Anophelines	
		H	C	H	C	H	C	H	C	H	C	H	C
Maseet	Oct'93	0	35.4	0	1.0	0	2.0	0	30.0	0	0	0	68.0
	Nov'93	0	14.0	0	1.0	0	6.0	0	10.0	0	0	0	31.0
	Dec'93	0	3.0	0	1.0	0	2.0	0	0.0	0	0	0	6.0
	Jan'94	0	4.5	0	1.5	0	1.0	0	0.0	0	0.5	0	7.5
Sarovar Nagar	Nov'93	2	49.0	0	4.0	0	5.0	0	9.0	0	0	2	67.0
	Dec'93	0	32.0	0	3.0	0	0.0	0	0.0	0	0	0	38.0
	Jan'94	0	2.0	0	3.0	0	0.0	0	0.0	0	0	0	5.0
Jhagar Puri	Dec'93	1	7.0	0	0.0	0	0.0	0	0.0	0	0	1	7.0
	Jan'94	0	2.0	0	0.5	0	0.0	0	0.0	0	0	0	2.5

H - Human dwellings; C - Cattle sheds

were found resting inside houses. Higher density of An. culicifacies was observed in the month of October (35.4) in Maseet and November (49.0) and December (32.0) in Sarovar Nagar (Table 7).

Epidemiological investigation: During the study period a total of 696 blood smears were collected which revealed a high incidence of malaria (SPR - 21.2%) particularly falciparum malaria (SfR - 16.8%) from the three villages of Gadarpur PHC (Table 8). The spleen enlargement rate (SER) was 61.25% in the children from 2 to 10 years of age.

Larvicidal efficacy of biocides

In limited breeding grounds the larvicidal efficacy of two Russian origin biocides viz., Spherix and Bactoculicide were observed at dosages of 1.0 gm/sq m and 0.5 gm/sq m, respectively, and per cent reduction in density of mosquito larvae (III+IV) were recorded upto 28 days post-treatment period. The tanks with Spherix showed 100 per cent reduction in anopheline larval density from Day 5 to Day 28, whereas in pokhars complete reduction of anopheline larvae started from Day 1 to Day 3 and then slightly low reduction was observed up to Day 28 (Fig. 4). In Bactoculicide more than 91 per cent reduction in anopheline and culicines was observed in pokhars up to Day 4 and at later period fluctuations in densities were observed up to Day 14 (Fig. 5), whereas 100 per cent reduction in culicine density in tank was observed up to Day 7. Further observations could not be carried out due to drying of tanks and pokhars.

TABLE 8: HALDWANI: FOCAL EPIDEMIC INVESTIGATIONS OF GADARPUR PHC VILLAGE

Village name	Month/ year	BSE	Pv	Pf	Mix	Total +ve	SPR	SfR
Sarovar Nagar	Sep '93	28	2	2	-	4	14.2	7.1
	Nov '93	68	4	10	1	15	22.0	16.1
	Dec '93	7	-	-	-	-	-	-
	Jan '94	14	-	1	-	1	7.1	7.1
Maseet	Oct '93	90	3	28	2	33	36.6	33.3
	Nov '93	439	19	63	1	83	19.0	14.6
	Dec '93	16	-	5	-	5	31.2	31.2
	Jan '94	9	-	1	-	1	11.1	11.1
Jhagar Puri	Oct '93	17	3	1	1	5	29.4	11.1
	Dec '93	7	-	1	-	1	14.2	14.2
	Jan '94	1	-	-	-	-	-	-

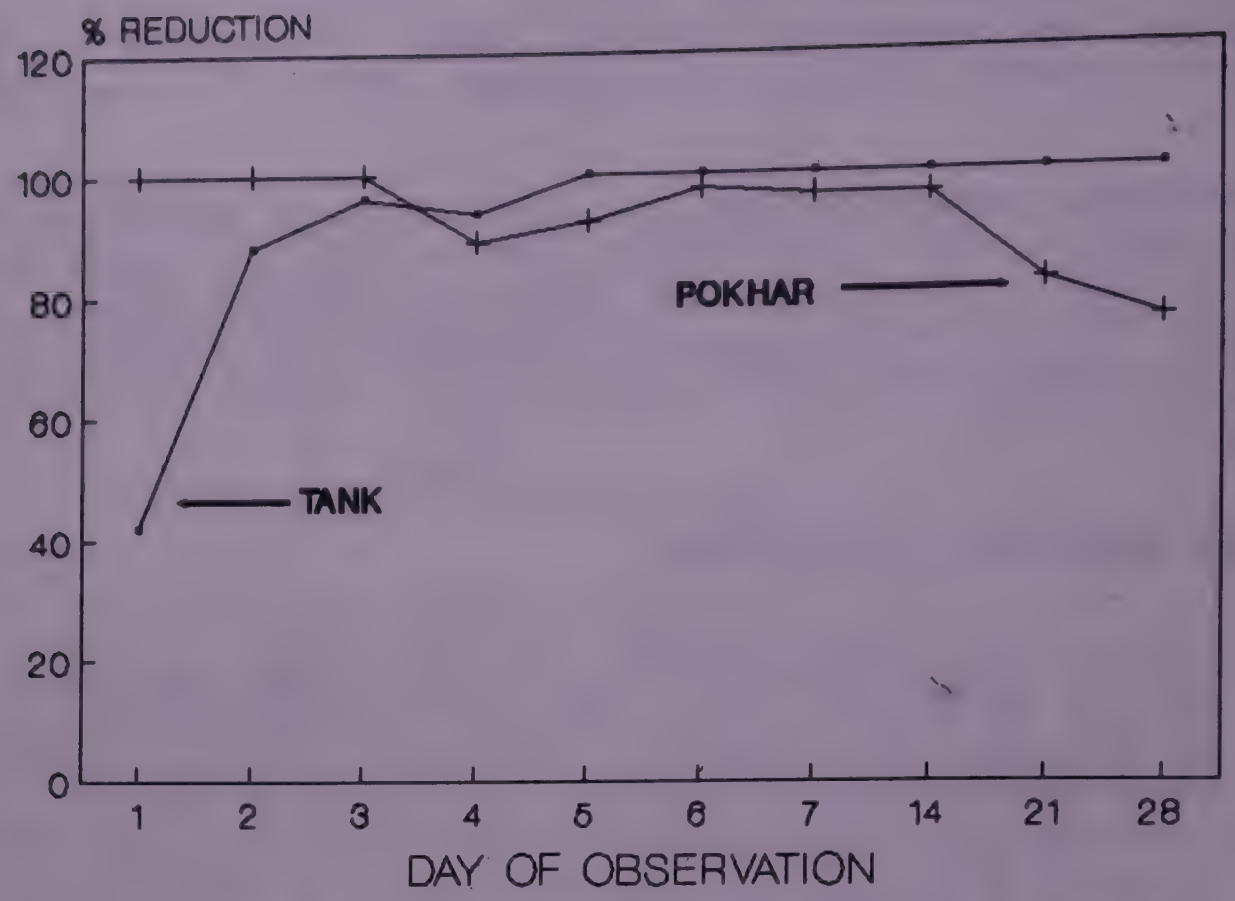


Fig. 4: Haldwani: Impact of Spherix (B. sphaericus) on Anopheline larval density

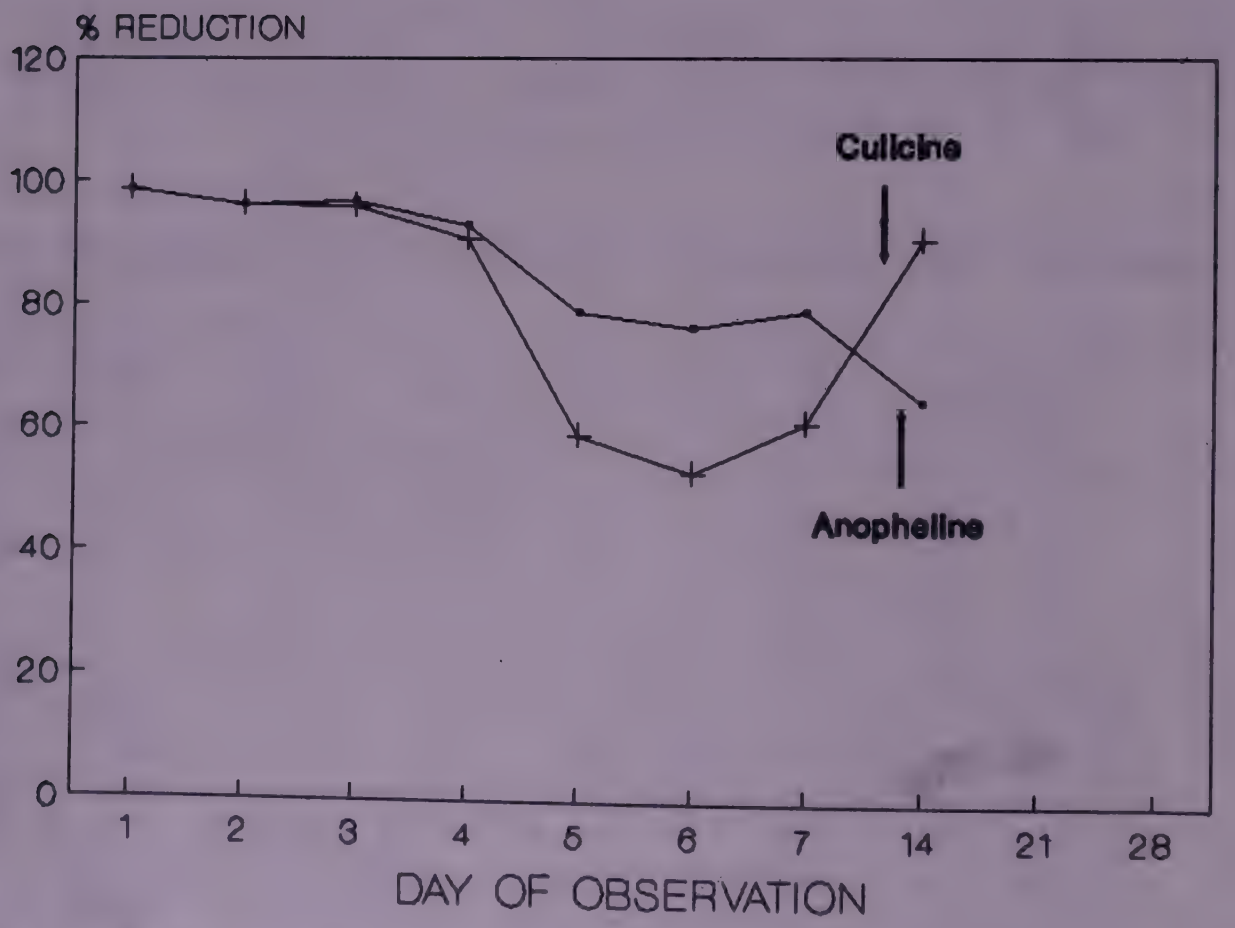


Fig. 5: Haldwani: Impact of Bactoculicide (B. thuringiensis) on Anopheline and Culicine larvae in Pokhar

Malaria clinic

The clinic data revealed high SPR (27.1%) and SfR (11.1%) in the month of June and January respectively. However, comparing the data from previous year this clearly showed a declining trend of malaria in this region. The data is very explanatory to show that malaria transmission extends from June to September (Fig. 6).

Microfilaria prevalence in two communities

Terai area of district Nainital being the rich green bowl of India, invites migrant agriculture labourers from far flung areas and thus the scope of spread of disease or new strains remains wide open. A total of 276 blood smears from agriculture/industrial labourers (migrant - population) were prepared for malaria and microfilaria infection. Though malaria positivity was low in both groups but micro-filaria prevalence rate was high (4.24%) in migrant labourers than non-migrant (1.08%) population (Table 9). This preliminary observation calls for much more attention for detection of microfilaria carriers and vector behaviour to delimit the transmission.

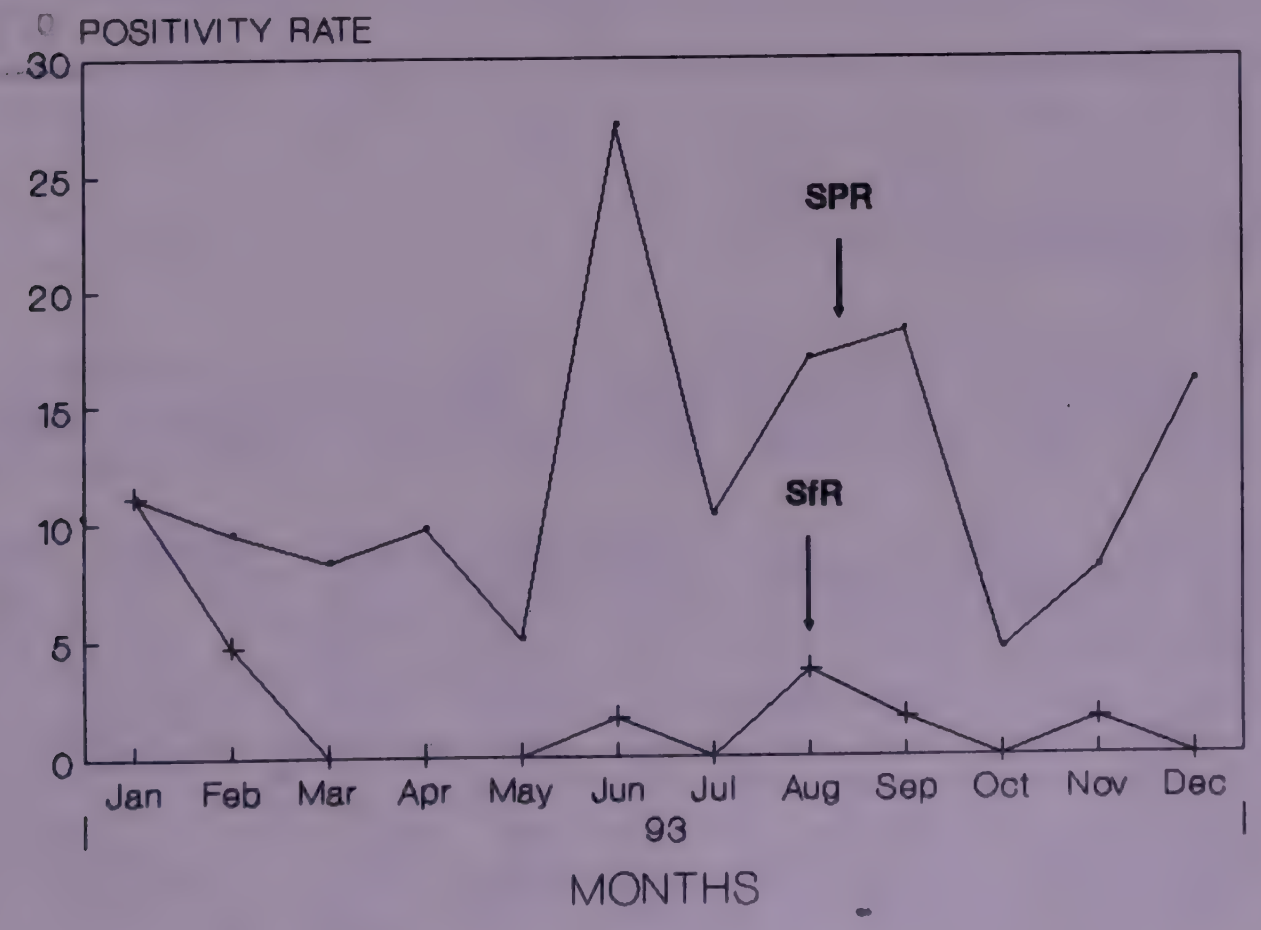


Fig. 6: Haldwani: Malaria clinic - parasitological data

TABLE 9: HALDWANI: MICROFILARIA PREVALENCE IN TWO COMMUNTIES OF DISTRICT NAINITAL

Labour/ colony	BSE	Microfilaria Positive		Malaria Positive				
		Total	Rate	Pv	Pf	Total	SPR	SfR
A. Migrants:								
LRC	251	10	3.98	-	-	-	-	-
CRC	111	3	2.72	1	1	2	1.80	0.90
HRC	112	-	-	1	-	1	0.89	-
Jha colony	111	4	3.60	-	-	-	-	-
Sanjay colony	63	2	3.17	-	-	-	-	-
Indira colony	176	16	9.09	-	-	-	-	-
Total	824	35	4.24	2	1	3	0.36	0.12
B. Migrants:								
Jawahar Nagar	79	-	-	-	-	-	-	-
Mat Kota	65	1	1.53	2	-	2	3.07	-
Kopa Lal Singh	62	2	3.22	-	-	-	-	-
Madna Pur	70	-	-	-	-	-	-	-
Total	276	3	1.08	2	-	2	0.72	-

Biological control:

In biological control Gambusia affinis is extensively used in various types of breeding sites. Thirty Gambusia fish stock (hill-6, bhabar-14, terai-10) are maintained in the district.

Four local fishes viz., Puntius ticto, Esomus danricus, Danio rerio and Chela labuca were tested @ 5 fish/sq m in paddy fields from July to August, 93 for their efficacy in controlling anophelines and culicines larvae. Per cent reduction in immature density over control was observed upto 35 days after fish release for both anophelines and culicines. All the four fishes showed 31 to 100 per cent reduction for controlling anophelines up to 28 days of post introduction. During the last week of observation i.e. 35 days after treatment, re-appearance of immature density might be due to flushing or dispersal of fishes due to very heavy rainfall.

(III) SHANKARGARH, ALLAHABAD DISTRICT, U.P.

Shankargarh is situated on the south bank of river Yamuna and is about 42 Kms from Allahabad. The region has highly endemic malaria mainly due to presence of numerous breeding sites including abandoned and active silica/stone quarries. The development of insecticides and drugs resistance has resulted in increase in the number of malaria cases, especially of Plasmodium falciparum. The problem is aggrivated by the seasonal migration of labourers from neighbouring district. To tackle the problems in June 1987, bioenvironmental control strategy was launched. After 5 years of successful implementation the area is under maintenance phase and at present only active surveillance is being carried out in the stone quarry areas and a clinic is functioning at the PHC campus.

Parasitological Survey in Stone Quarries: The problem of malaria in this area is mainly due to stone quarries and labour movement. Data on stone quarries covering a population of 2877 is given in Table 1. Out of a total of 2357 blood slides examined during the period from November 92 to September 93, 714 cases were found positive for malaria parasites. Of these 227 were positive for P. vivax, 485 for P. falciparum and 2 for mixed infection. The SPR recorded was 30.3% and SfR 20.7%.

TABLE 1: SHANKARGARH: PARASITOLOGICAL DATA IN STONE QUARRIES

Month	Population	BSC/E	Total +ve	+ve for			SPR	SfR
				Pv	Pf	Mix		
1992								
Nov	-	365	129	8	120	1	35.9	33.2
Dec	-	679	230	26	204	-	33.9	30.0
1993								
Jan	-	221	69	5	63	1	31.2	29.0
Feb	-	135	36	3	33	-	26.7	24.4
Mar	2877	208	51	16	35	-	24.5	16.8
Apr	2877	139	39	23	16	-	28.1	11.5
May	2877	97	28	22	6	-	28.9	06.2
Jun	2877	101	37	35	2	-	36.6	02.0
Jul	2877	108	32	32	-	-	29.6	00.0
Aug	2877	167	30	28	2	-	17.9	01.1
Sep	2877	137	33	29	4	-	24.0	02.9
Total	2877	2357	714	227	485	2	30.3	20.7

TABLE 2: SHANKARGARH: MALARIA CLINIC DATA

Year	BSC/E	Total +ive	+ve for			SPR	SfR
			Pv	Pf	Mix		
1992							
Oct	1720	797	232	564	1	46.3	32.8
Nov	2109	1192	188	1003	1	56.5	47.6
Dec	1429	906	130	770	6	63.4	54.3
1993							
Jan	866	534	51	480	3	61.7	55.8
Feb	495	189	35	154	-	38.2	31.1
Mar	464	166	57	109	-	35.8	23.5
Apr	391	169	80	89	-	43.2	22.8
May	432	161	148	12	1	37.3	03.8
Jun	668	312	302	10	-	46.7	01.5
Jul	736	214	208	5	1	29.1	00.8
Aug	1001	344	331	13	-	34.4	01.3
Sep	975	286	261	24	1	29.3	02.5
Total	11286	5270	2023	3233	14	46.70	28.8

TABLE 3: SHANKARGARH: YEARWISE MALARIA CLINIC DATA

Year	BSC/E	Total +ive	+ve for			SPR	SfR
			Pv	Pf	Mix		
1988	7309	3334	2001	1329	4	45.6	18.6
1989	8200	4543	1873	2663	7	55.4	32.7
1990	12209	7019	2269	4748	2	27.5	38.9
1991	15473	8126	2788	5314	24	52.5	34.5
1992	16662	7719	3353	4358	8	46.3	26.2
1993*	9039	3646	1910	1728	8	40.3	19.2

* - Till September 1993

Malaria Clinic: The malaria clinic takes care of the local population as well as of those from neighbouring villages. Recently clinic has been shifted from the Centre to the PHC campus which has resulted in reduction of staff and thus the number of slides examined were slightly lower during the period from October '92 to September '93. A total of 11286 blood slides

were examined, out of which 5270 were positives. The SPR was 46.7% and SfR 28.8% (Table 2). Table 3 shows yearwise epidemiological data of SPR and SfR showing a continuous decline since 1990.

Infant and Child Parasite Rate: Data from October '92 to September '93 on the infant and child parasite rate has been presented in Tables 4 and 5. Out of a total of 124 slides examined in the age group of 0-1 years, 44 were found positive for malaria parasites, while in the age group of 1-10 years, 3227 slides were examined and 1555 were found positive for malaria parasites. The infant and child parasite rates recorded were 35.5% and 48.2% respectively. Month-wise data shows that there is a high degree of perennial transmission, from May to November there was a predominance of *P. vivax* and from October to January *P. falciparum* cases were high.

Chloroquine Sensitivity in *P. vivax* in-vivo: An extended study was conducted during the month of August-September 1993, for evaluating sensitivity to chloroquine using standard WHO method. From malaria clinic and stone quarries 94 patients showing parasitaemia (Pv) were selected for the study. A standard (600 mg + 600 mg + 300 mg) of 10 tablets as adult dose over a period of

TABLE 4: SHANKARGARH: INFANT PARASITE RATE IN 1 - 10 YEARS AGE GROUP

Month	Collection			+ve *Pv*			+ve *Pf*			Total M & F			IPR
	M	F	Total	M	F	Total	M	F	Total	*Pv*	*Pf*	Total	
1992													
Oct	7	8	15	3	1	4	1	-	1	4	1	5	33.3
Nov	9	9	18	4	3	7	3	3	6	7	6	13	72.2
Dec	1	3	4	-	-	-	1	1	2	-	2	2	50.0
1993													
Jan	9	5	14	1	-	1	5	1	6	1	6	7	50.0
Feb	3	-	3	-	-	-	-	-	-	-	-	-	-
Mar	3	2	5	1	-	1	-	-	-	1	-	1	20.0
Apr	2	4	6	1	-	1	-	1	1	1	1	2	50.0
May	5	4	9	-	-	-	1	-	1	-	1	1	11.1
Jun	8	4	12	2	-	2	-	-	-	2	-	2	16.7
Jul	10	4	14	2	-	2	-	-	-	2	-	2	18.3
Aug	7	3	10	2	-	2	-	-	-	2	-	2	20.0
Sep	6	8	14	2	4	6	1	-	1	6	1	7	50.0
Total	70	54	124	18	8	26	12	6	18	26	18	44	35.5

TABLE 5: SHANKARGARH: CHILD PARASITE RATE IN 1 - 10 YEARS AGE GROUP

Month	Collection			+ve Pv			+ve Pf			Total M & F			CPR
	M	F	Total	M	F	Total	M	F	Total	Pv	Pf	Total	
1992													
Oct	217	178	395	41	28	69	70	57	127	69	127	196	49.6
Nov	312	222	534	35	32	67	148	109	257	67	257	324	60.7
Dec	189	179	368	22	12	34	102	119	221	34	221	255	69.3
1993													
Jan	137	111	248	12	6	18	77	69	146	12	146	158	63.7
Feb	70	100	170	4	2	6	28	20	48	6	48	54	31.8
Mar	79	37	116	9	4	13	19	7	26	13	26	39	33.6
Apr	72	48	120	21	10	31	19	8	27	31	27	58	48.3
May	81	58	139	31	23	54	2	3	5	54	5	59	42.4
Jun	113	91	204	57	44	101	-	5	5	101	5	106	52.0
Jul	139	98	237	48	27	75	1	1	2	75	2	77	32.5
Aug	175	111	286	59	39	98	-	-	-	98	-	98	34.3
Sep	284	126	410	84	41	125	6	-	6	125	6	131	32.0
Total	1868	1359	3227	423	268	671	472	398	870	685	870	1555	48.2

three days was administered. Blood smears were collected on days 0, 7, 14, 21 and 28. No case of parsitaemia reappeared within 28 days.

(IV) SHAHJAHANPUR DISTRICT, UTTAR PRADESH

Field evaluation of biocides to control malaria in rural areas of Farrukhabad district, Uttar Pradesh

A focal outbreak of malaria occurred in some villages of Talegram PHC, Farrukhabad district during the post-monsoon season of 1991. Occurrence of epidemic once again proved that the present control measures were inadequate to control malaria, indicating thereby the need of additional tools to tackle the situation. From the epidemic affected area, 38 villages of sub PHC Gursahaiganj were selected for malaria control for testing two strains of biocides viz; Spherix (Bacillus sphaericus) and Bactoculicide (Bacillus thuringiensis israelensis) imported from Russia. Following objectives were kept in view:-

1. To study the impact of large-scale field applications of biocides in controlling mosquitoes in rural areas.

2. To assess the impact of biocide spray on transmission of malaria.

3. To study the operational feasibility of large-scale field applications of biocides in various types of mosquito breeding habitats.

4. To determine the cost of biocide applications to control malaria per 1000 population.

Farrukhabad district of U.P. is situated between 70-80 degrees east longitude and 27-28 degrees north latitude. Its adjoining districts are Badayun and Shahjahanpur in the north, Hardoi in the east, Kanpur and Itawah in the south and Etah and Mainpuri in the west. The river Ganga flows through the north-east boundary of the district. The terrain is gangetic plain with sandy soil having high water absorption capacity. Temperature ranges from 6-44 degrees centigrade during the year. There is a mean annual rain of 62.5 mm with rainy season from July to September. Small precipitation occurs in the beginning of the year. There are a lot of xerophytic shrub vegetation in the area.

The district consists of 16 PHCs including Talgram. The latter has 3 sub-PHCs. Gursahaiganj is one of them. It is situated on the historic Grand Trunk (GT) road at a distance of about 325 Kms east of Delhi and 105 Kms west to Kanpur.

The villages selected for biocide spray are located within a radius of 20 Kms from Gursahaiganj (Fig. 1). Malaria control by DDT spray and chemotherapy was carried out by NMEP prior to launching of the present strategy during March, 1993. After this

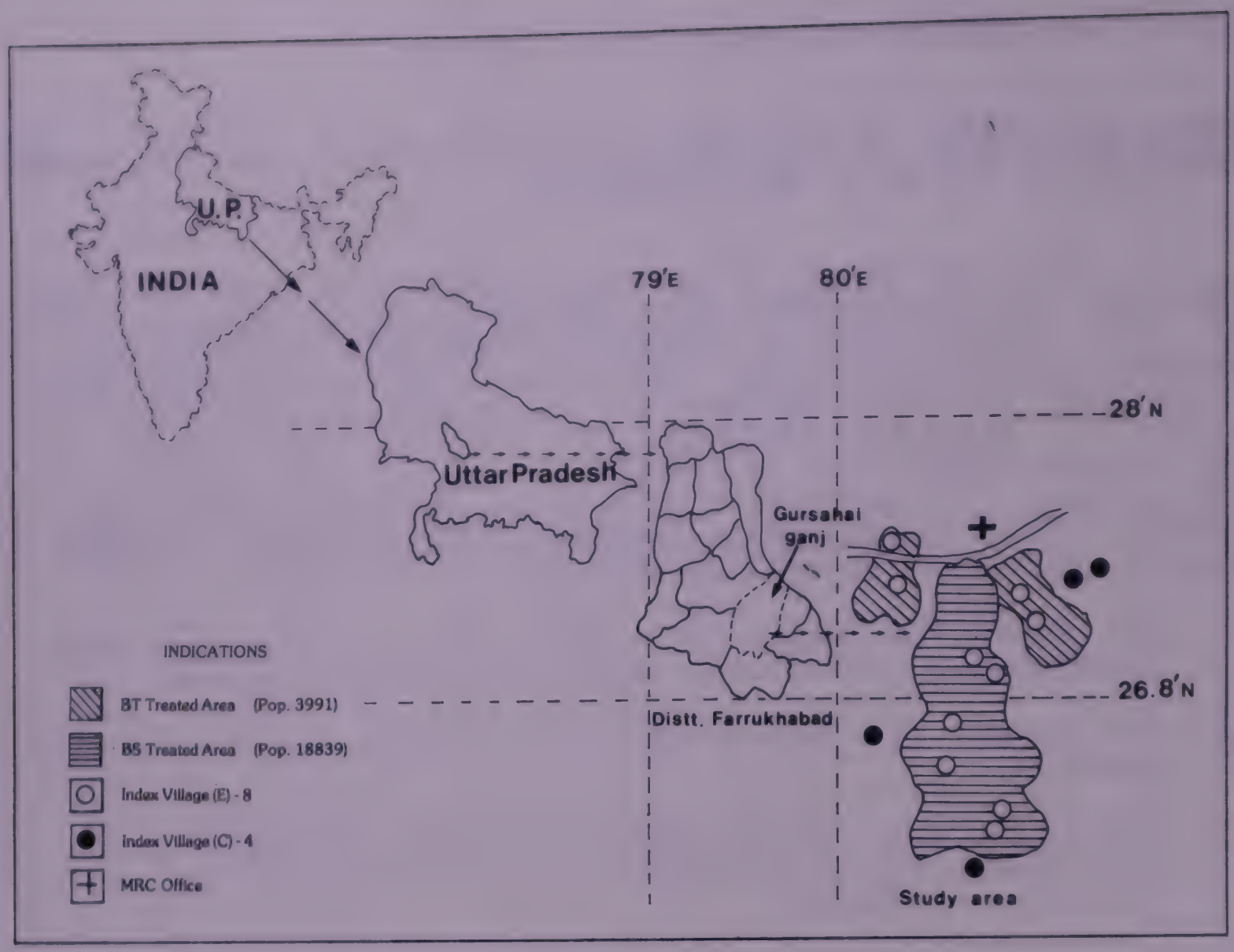


Fig. 1: Farrukhabad: Experimental area of district Farrukhabad (U.P.)

all control measures except radical treatment were withdrawn from these villages. Four adjoining villages (2 against BS and 2 against BT) under NMEP operations were held for comparison. Before application of biolarvicides villagewise baseline information on population, geographical reconnaissance for mapping mosquito breeding potential, adult mosquito densities and parasite incidences were collected during February-March 1993. Census revealed human population of 22,830 (12,498 male and 10,332 female) and 12,998 cattles. Ratio of human to cattle population was 1.8:1.0. Geographical reconnaissance revealed mosquito breeding potentials and is given in Table 1. The mosquito breeding sites were water collections in pits, pitchers, street drains, tanks, waste water collections near community taps and wells, in an area of about 5391 sq m.

Peridomestic breeding sites were temporary and permanent ponds, lakes, seepage collections, irrigation channels, tube wells, cold storage tanks, roadside borrowpits and seasonal drains. The area of these breeding sites was 34,982 sq m.

TABLE 1: FARRUKHABAD: RESULTS OF GEOGRAPHICAL RECONNAISSANCE TO MAP MOSQUITO BREEDING SITES IN 38 EXPERIMENTAL AND 4 CONTROL VILLAGES OF FARRUKHABAD DISTRICT (MARCH, 1993)

Sites	Expt.	Control
DOMESTIC BREEDING		
Street Drain		
Number	184	20
Area (sq m)	4361 (115)	480 (120)
Pits		
Number	315	82
Area (sq m)	978 (26)	95 (24)
Tanks		
Number	26	9
Area (sq m)	52 (1.4)	31 (7.8)
Wells		
Number	461	51
Unused/Dry	383	45
PERIDOMESTIC BREEDING		
Ponds inside village		
Number	125	28
Area (sq m)	19013 (500)	1650 (413)
Ponds outside village		
Number	25	3
Area (sq m)	5012 (132)	1000 (250)
Lakes		
Number	7	-
Area (sq m)	6150 (162)	-
Seasonal Drains		
Number	24 dry	3 dry
Tube well tanks		
Number	328	75
Area (sq m)	625 (16.4)	109 (27.3)
Irrigation seepage		
Number	37	4
Area (sq m)	3050 (80.3)	600 (125)
Borrow pits		
Number	92	60
Area (sq m)	1132 (29.8)	650 (10.8)

Figures in parentheses indicate average area of breeding site per village

There is no river or irrigation canal in the selected villages. However, extensive irrigation is done through tube wells. On an average 15 tube wells per village is common sight. Water from tube wells is taken through irrigation channels with

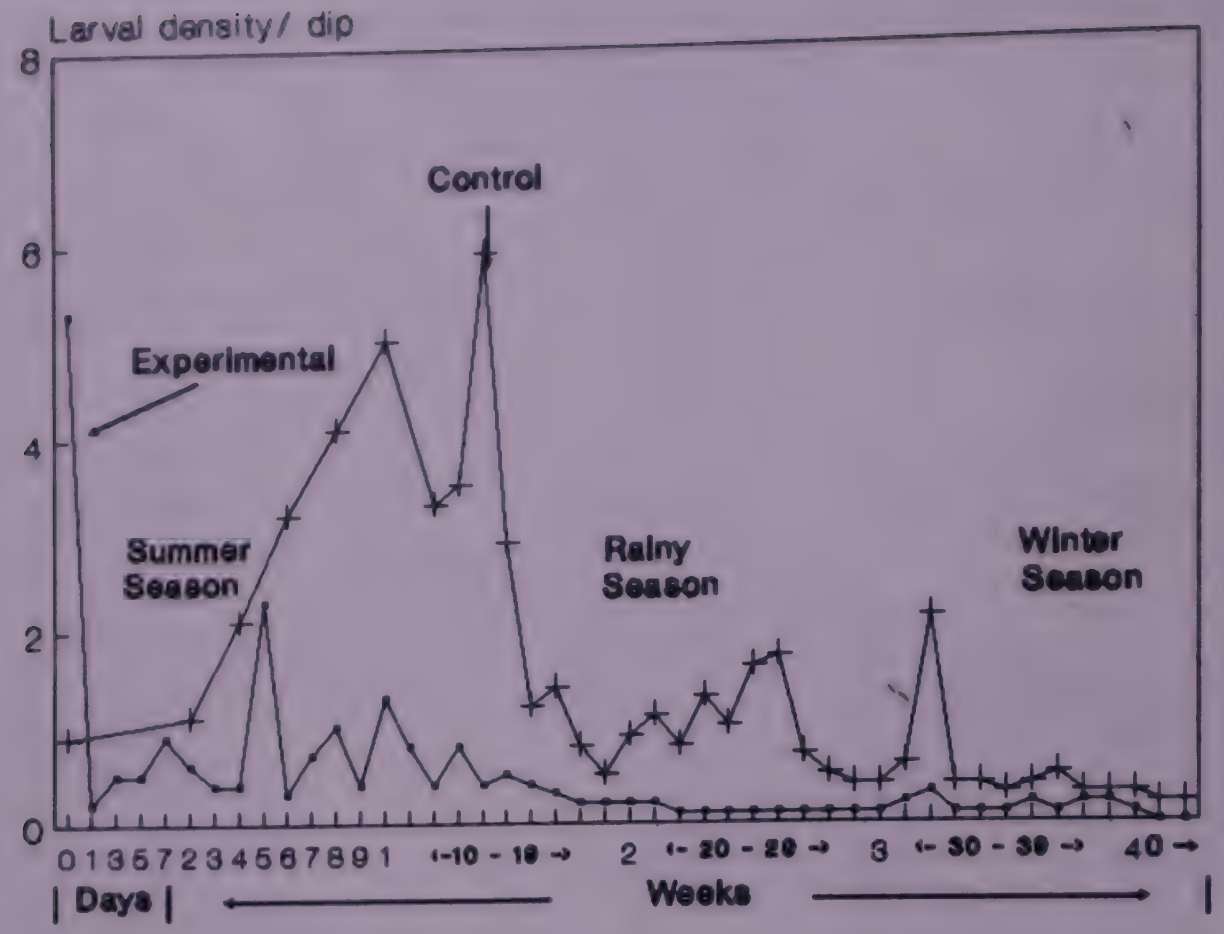


Fig. 2: Farrukhabad: Overall impact of Spherix on Anopheline larvae

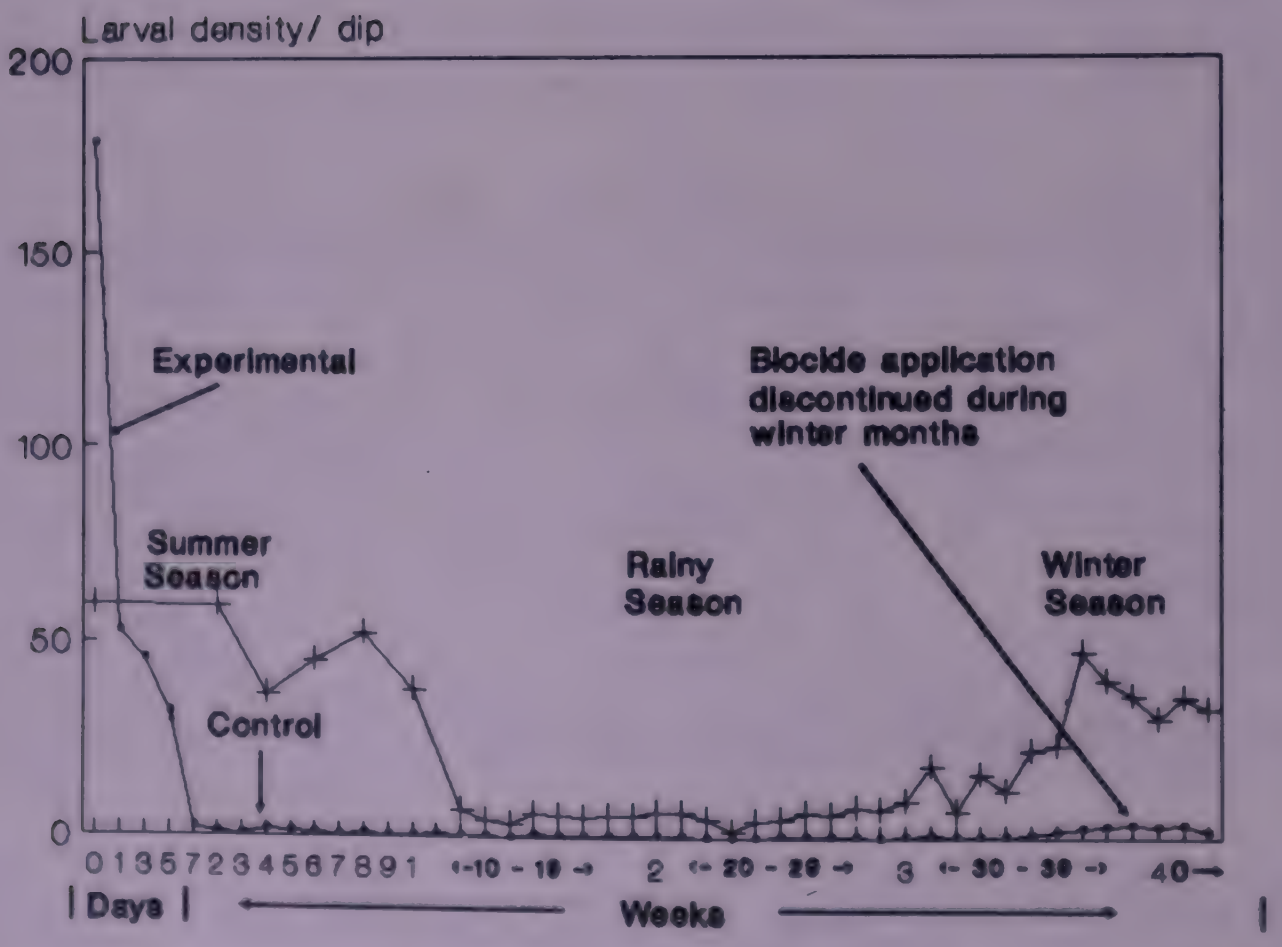


Fig. 3: Farrukhabad: Overall impact of Spherix on Culex larvae

kachha embankment throughout their length. Numerous rat holes are found in them. During the survey 383 wells out of 461 searched were found dry.

The main economic activities of the people are farming and bidi making. The major crops grown in the area are potato, sunflower, wheat, maize, groundnut and pulses. Rice and sugarcane are cultivated only in a limited area. Some of the above mentioned crops require 5-6 times watering till their maturity. This resulted in more spillage of water and thus aggravating the mosquito problem.

Mosquito fauna: Adult hand collection of mosquitoes carried out during March, 1993 revealed prevalence of 3 anophelines viz., An. culicifacies, An. annularis, An. subpictus and also culicine mosquitoes. Per man hour densities of these were found 42.3, 0.7, 9.7 and 32.3 respectively.

Parasite incidence: Rapid fever surveys carried out during the above period revealed slide positivity rate of 9.5 per cent.

Biocide spray: A cluster of 6 villages was selected for Bactoculicide (Bt) and the remaining 32 for Spherix (Bs) treatment. For larval impact 3 villages under Bt treatment and 8 villages of Bs were kept as indicator sites. Impact of antilarval sprayng on the immature densities monitored weekly from March to December, 1993 is discussed below:

Impact of Spherix

Impact on anopheline breeding: Spherix with a dose of 1 gm/sq m was applied in ponds, pools, pits, ditches and drains. Impact was measured in each habitat. Anopheline larval density per dip before application (Day 0) was 5.3 which on days 1,3 and 5 post-applications declined to 0.2, 0.5 and 0.5. On day 7 density per dip was 0.9 (Fig. 2). Pupal density declined from 0.2 (Day 0) to 0 (Day 7). Further observations revealed a continuous decline in the immature density. However, on 5th week (first week of May) there was a sudden increase in anopheline larval density owing to profuse breeding of seasonal mosquito An. subpictus in pits and ponds. However, breeding was checked by re-application of Spherix.

Impact on culicine breeding: Density of III and IV instar culicine larvae before application (Day 0) was 178.9 per dip in experimental habitats. On day 1 post-application it was 52.5. On day 5 it further declined to 31.9. Later weekly monitoring revealed a continuous decline in larvae (Fig. 3). Breeding reappeared in 10% of the treated habitats. Therefore, biolarvicides was reapplied in these sites. There was a

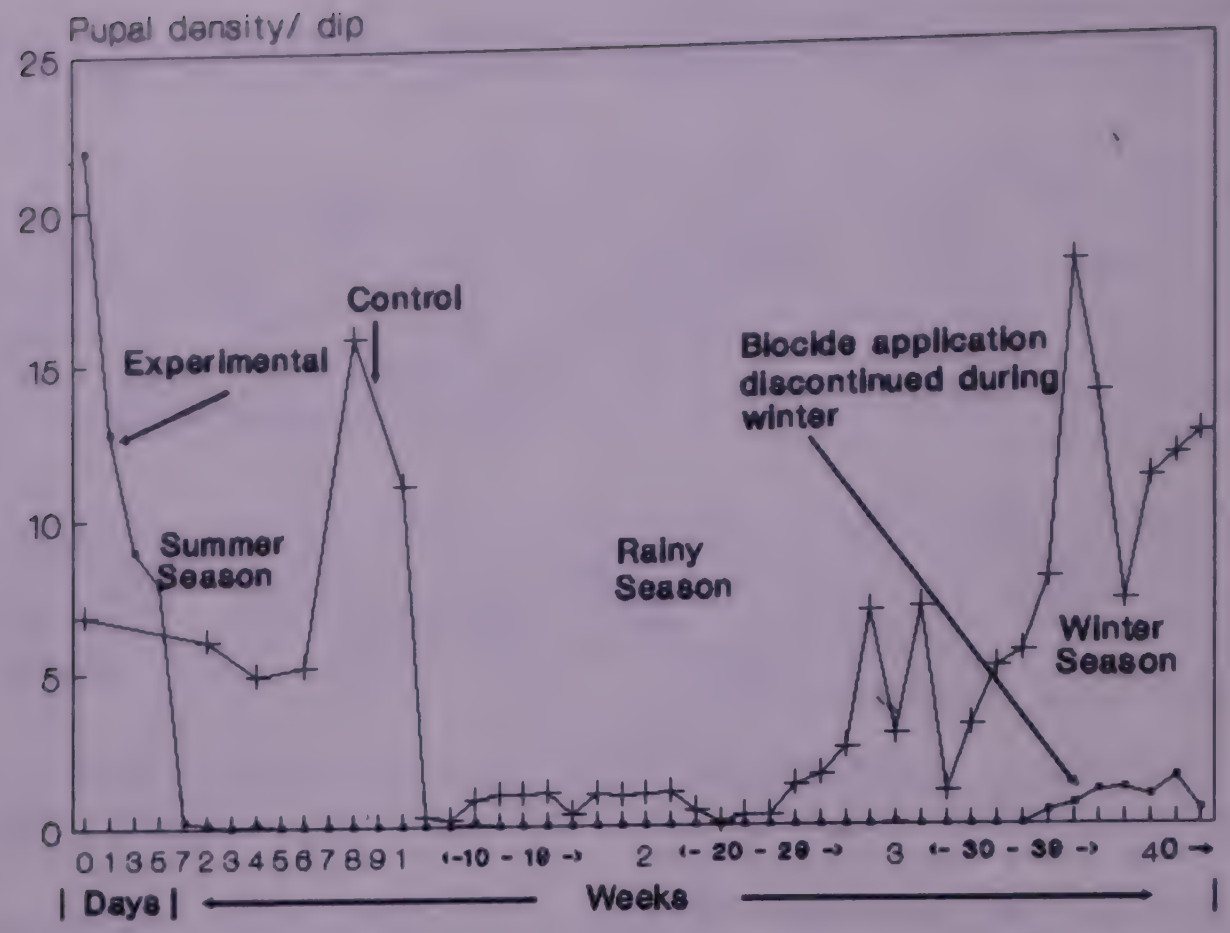


Fig. 4: Farrukhabad: Overall impact of B.S. spray on Culex pupal density

remarkable decline in pupal density in all breeding habitats (Fig. 4). Impact of Spherix was less in habitats infested with acquatic weeds. Effect of Spherix in undisturbed tanks lasted for about two weeks (Table 2). Mosquito breeding was supported by tube well tanks only during rainy season when the latter were unused for irrigation purpose.

For a comparative study, larval densities were monitored in control habitats fortnightly for 12 weeks thereafter it was made weekly like the experimental habitats. The results revealed no continuous decline in immature densities as observed in experimental sites. Overall, Spherix @ 1gm/sqm effectively controlled mosquito breeding in various habitats. It would not be out of place to mention that biocide spray had similar impact on immature densities during different seasons of the year. However, the impact during peak summer and rainy season could not be evaluated because of drying and flooding in both control and experimental sites.

Spray operations were suspended from 15th December onwards. However, small-scale field trials were carried out during the above period. Results of these trials are given in Table 3 which indicates Spherix was effective even during winter season in this area. The activity was found slower because mortality started after 48 h whereas in summer heavy mortality occurred after 24 h itself.

TABLE 2: FARRUKHABAD: IMPACT OF SPHERIX ON MOSQUITO LARVAE IN TUBE WELL TANKS

Month/ year	Days of observation	Density per dip							
		Anopheline				Culicine			
		III & IV		Pupae		III & IV		Pupae	
		Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Jul '93	0 day	3.0	3.6	0.6	0.4	12.4	5.0	2.2	0.9
	1	0.0	1.7	0.0	0.1	0.0	3.0	0.0	0.5
	3	0.0	1.5	0.0	0.2	0.0	3.1	0.0	0.6
	5	0.0	1.5	0.0	0.2	0.0	3.1	0.0	0.6
	7 (1 week)	0.0	0.7	0.0	0.0	0.0	3.8	0.0	0.5
	2	3.9	1.1	0.1	0.0	0.0	0.0	0.0	0.0
	3	1.9	1.5	0.1	0.2	4.5	0.5	0.7	0.0
	4	0.3	4.2	0.0	0.1	0.2	4.0	0.0	0.9
	5	1.6	8.2	0.1	1.2	0.7	2.9	0.1	0.3
	6	0.3	10.4	0.0	1.2	0.6	2.3	0.0	0.3
	7	0.1	10.0	0.0	1.9	0.4	1.1	0.0	0.2
	8	0.2	1.5	0.0	0.0	0.4	2.6	0.0	0.2
	9	0.2	0.0	0.0	0.0	0.0	2.6	0.0	0.5
	10	0.0	0.9	0.0	0.0	0.7	1.5	0.0	0.3
	11	0.1	3.8	0.0	0.0	0.0	2.1	0.0	0.4
	12	0.5	3.0	0.0	0.2	0.9	1.2	0.1	0.5
	13	0.3	4.0	0.0	0.6	0.3	3.2	0.0	0.2
	14	0.1	3.0	0.0	1.0	0.3	4.6	0.0	0.6
	15	0.1	3.2	0.0	0.6	0.5	5.0	0.0	1.4
	16	0.3	0.0	0.1	0.0	0.2	3.4	0.0	0.8
	17	0.2	2.6	0.0	0.8	0.0	3.2	0.0	0.4

Note: Tanks contained fresh water due to reuse of tube wells for irrigating potato crop after October, therefore larvae were washed away and further observations were discontinued in such habitats

TABLE 3: FARRUKHABAD: EFFECT OF SPHERIX ON CULICINE LARVAE DURING WINTER SEASON

Day of observation	PERIOD OF FIELD TRIAL					
	13.12.93 to 20.12.93			24.1.94 to 31.1.94		
	Density/Dip		% Mortality (III & IV instar)	Density/Dip		% Mortality (III & IV instar)
	Expt.	Cont.		Expt.	Cont.	
0 Day	276.3	103.9	0.0	88.0	60.8	0.0
1	187.3	168.2	32.0	196.8	89.9	85.0
2	161.7	151.0	59.8	39.0	290.8	91.0
3	110.0	150.7	74.1	1.7	193.6	99.0
5	3.0	155.0	99.3	0.2	174.6	100.0
7	1.5	156.4	100.0	23.3	101.0	84.0

During field trials it was found that after 15 rounds of spray (105 days after initial spray) impact on culicine larvae started declining in some peri-domestic pits. Reasons for this decline are under study.

Impact of Bactoculicide: Bactoculicide was applied @ 0.5 gm/sq m in all types of breeding habitats. Per cent reduction in all III and IV instar larval density is given in Fig. 5. Additional breeding sites treated with Bactoculicide were seepages of irrigation channels which supported breeding of An. culicifacies alongwith An. subpictus, An. annularis, An. nigerrimus, An. aconitus and culcine mosquitoes. Irregular supply of water in irrigation channels and its mixing with old water intermittently disturbed the biolarvicides applied in these sites. Therefore, spraying had a less impact. Overall impact of Bactoculicide on mosquito breeding was similar to that of Spherix.

Impact of adult mosquito population: Impact of biocide spray was assessed on adult mosquito population. For this adult hand collections of mosquitoes were carried out at fortnightly intervals from indicator villages.

Adult densities of total mosquitoes, anophelines, culicines and vector in experimental area treated with Spherix varied from

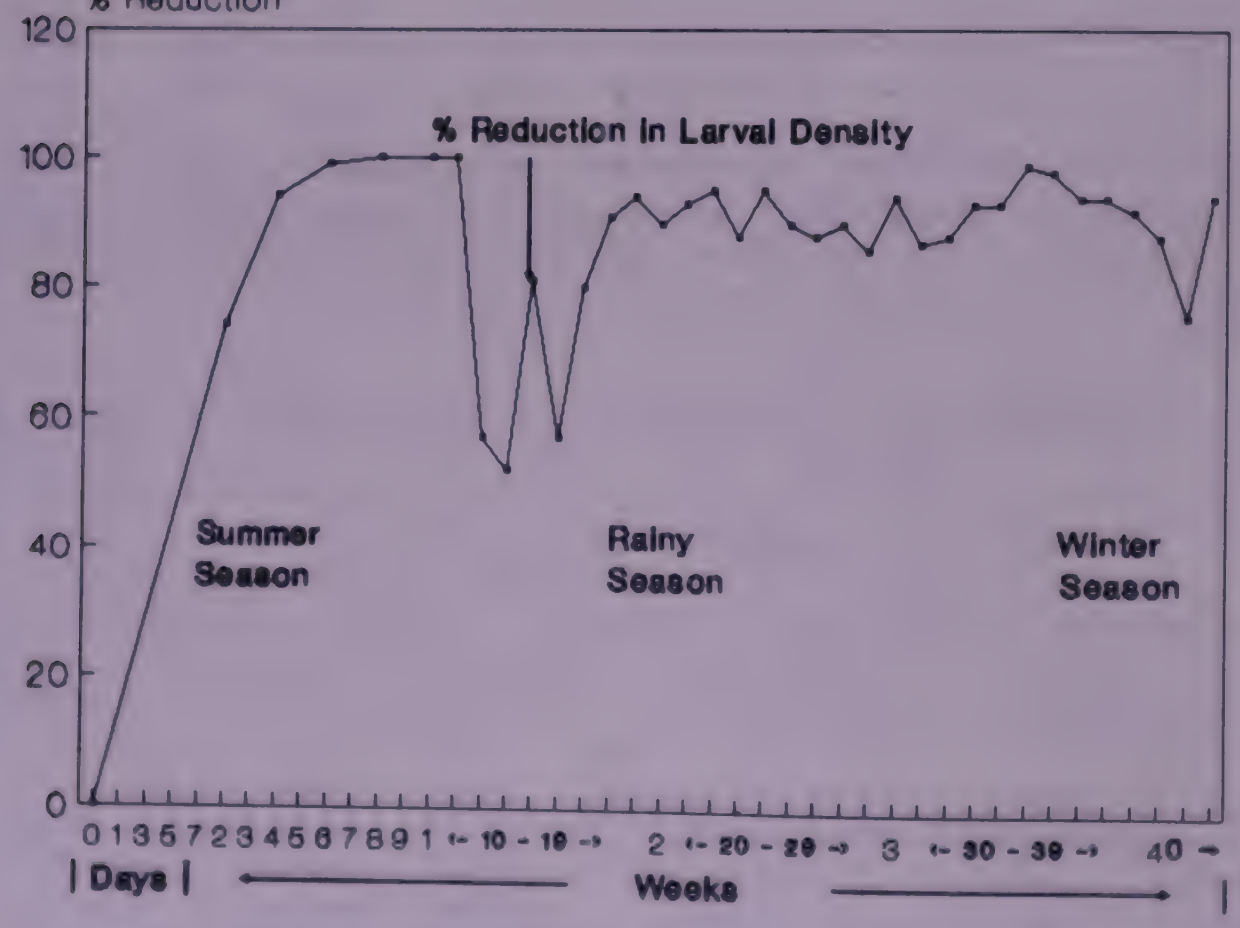


Fig. 5: Farrukhabad: Per cent reduction in Anopheline larvae (III & IV instar) in habitats treated with bactoculicide

23.0 to 108.5, 3.0 to 67.0, 7.0 to 61.5 and 0.0 to 3.5 respectively, whereas in control area (under NMEP) the figures varied from 33.0 to 126.0, 4.0 to 105, 17.0 to 102.5 and 0.0 to 5.5 respectively (Table 4). Vector densities both in experimental and control areas were comparable. Impact was more pronounced on culicine densities.

Results of adult mosquito densities obtained in Bactoculicide treated and control area (under NMEP) are given in Table 5. Per man hour densities of total mosquitoes, anophelines, culcicines and vector varied from 27.0 to 204, 15.5 to 161.0, 7.0 to 108 and 1.0 to 63.0 in experimental area respectively. In control area the figures varied from 34.5 to 175.0, 16.0 to 116.0, 15.0 to 94.0 and 0.0 to 52.0 respectively. These results indicated good impact of Bactoculicide on culicine larvae. Due to heavy seepage water collections An. culicifacies densities remained comparable in both the areas.

Effect on non-target organism: Effect of biocide spray on non-target organisms like naids of dragon and damsel flies was also

TABLE 4: FARRUKHABAD: MAN HOUR DENSITIES OF MOSQUITOES IN AREA UNDER BIOCIDE (SPHERIX) AND WITHOUT BIOCIDE (RESIDUAL INSECTICIDE SPRAY UNDER NMEP) SPRAY

Month/ Year	Fort-night	Mosquito		Anopheline		Culicine		Vector	
		BS	RI	BS	RI	BS	RI	BS	RI
	I			NOT DONE					
Apr '93	II	108.5	113.0	47.0	105.0	61.5	102.5	1.0	4.0
	I	23.0	66.0	15.0	33.0	8.0	33.5	0.5	0.5
May	II	23.0	95.0	15.0	42.0	7.0	53.0	0.5	0.5
	I	40.5	79.5	26.5	27.0	14.0	52.5	3.0	0.0
Jun	II	36.5	84.5	25.0	41.5	11.5	43.0	1.5	1.5
	I	68.0	126.0	48.5	85.5	19.5	40.5	1.5	5.5
Jul	II	66.5	121.5	45.0	94.5	21.5	27.0	0.5	4.5
	I	75.0	113.0	65.0	82.0	10.0	31.0	2.0	2.5
Aug	II	68.5	70.0	56.5	48.0	12.0	22.0	3.5	1.5
	I	54.0	74.5	45.5	56.5	8.5	18.0	2.0	2.0
Sept	II	77.5	82.5	56.0	60.5	21.5	22.0	0.5	0.5
	I	84.5	80.5	67.0	52.0	17.5	28.5	2.5	1.0
Oct	II	38.5	45.0	26.0	28.0	12.5	17.0	1.0	0.5
	I	34.5	44.5	20.0	23.0	14.5	21.5	1.5	1.0
Nov	II	38.0	45.0	21.0	25.0	17.0	20.0	0.0	0.0
	I	61.5	85.5	34.0	41.0	27.5	44.5	0.0	1.0
Dec	II	55.5	72.5	28.0	30.5	27.5	41.5	0.5	0.0
	I	29.5	39.5	4.0	4.0	25.5	35.5	0.0	0.0
Jan '94	II	28.5	33.0	3.0	5.0	25.5	28.0	0.0	0.0

BS = Area sprayed with spherix; RI = Area under residual insecticide spray

TABLE 5: FARRUKHABAD: MAN HOUR DENSITIES OF MOSQUITOES IN AREA UNDER BIOCIDE (BACTOCULICIDE) AND WITHOUT BIOCIDE SPRAY (RESIDUAL INSECTICIDE SPRAY UNDER NMEP)

Month/ Year	Fort-night	Mosquito		Anopheline		Culicine		Vector	
		BT	RI	BT	RI	BT	RI	BT	RI
	I				NOT DONE				
Mar '93	II	104.0	75.0	75.0	52.0	29.0	23.0	63.0	49.0
	I				NOT DONE				
Apr	II	204.0	175.0	96.0	81.0	108.0	94.0	49.0	52.0
	I	169.0	88.0	161.0	40.0	8.0	48.0	14.0	9.0
May	II	74.0	91.0	64.0	50.0	10.0	41.0	19.0	22.0
	I	42.0	57.0	35.0	40.0	7.0	17.0	9.0	13.0
Jun	II	86.0	69.0	69.0	48.0	17.0	21.0	7.0	6.0
	I	115.5	163.5	91.5	116.0	24.0	47.5	11.5	15.5
Jul	II	78.5	129.0	65.0	103.5	13.5	25.5	7.5	11.0
	I	111.5	121.5	104.0	86.0	7.5	35.5	14.0	9.0
Aug	II	86.5	86.0	77.0	65.5	9.5	20.5	3.5	6.0
	I	74.0	84.5	60.0	67.0	14.0	17.5	3.5	6.0
Sept	II	83.5	92.0	65.5	72.0	18.0	20.0	7.5	10.0
	I	62.0	66.0	52.0	51.0	10.0	15.0	1.5	3.0
Oct	II	41.5	54.0	26.5	31.0	15.0	23.0	1.5	2.5
	I	40.5	44.0	27.0	23.5	13.5	20.5	6.0	3.0
Nov	II	27.0	34.5	15.5	16.0	11.5	18.5	1.0	0.0
	I	50.0	63.5	36.5	40.0	13.5	23.5	3.5	4.5
Dec	II	48.0	62.5	30.0	35.0	18.0	27.5	3.0	7.0
	I	28.0	29.0	16.0	14.0	12.0	15.0	0.5	1.5
Jan '94	II	24.0	24.5	8.5	9.5	15.5	15.0	2.0	3.0

BT = Area sprayed with Bactoculicide; RI = Area under residual insecticide spray

TABLE 6: FARRUKHABAD: EFFECT OF BACTOCULICIDE ON NAIDS OF DRAGON AND DAMSEL FLIES

Days of Observation	Density per dip		% Mortality
	Experimental	Control	
0 Day	1.9	1.2	0.0
1	1.0	1.1	43.0
2	1.4	0.9	2.0
3	0.9	0.3	0.0
5	0.7	0.6	26.0
7	1.6	1.0	0.0

TABLE 7: FARRUKHABAD: RESULTS OF CHLOROQUINE SENSITIVITY TEST IN P. FALCIPARUM IN TWO PHCs OF DISTRICT FARRUKHABAD, U.P.

Case No.	Results	Urine test	Area of study	Following observation parasite count per cubic mm of blood							Remarks
				D0	D2	D5	D7	D14	D21	D28	
1.	pfrg	-ive	PHC	2986	400	0	0	0	0	0	Urine test was done on day 2 in all the cases to ensure chloroquine absorption
2.	pfrg	-ive	Jalalabad	480	0	0	0	0	0	0	
3.	pfrg	-ive	-	1333	0	0	0	0	0	0	
4.	pfrg	-ive	-	1520	0	0	0	0	0	0	
5.	pfrg	-ive	-	9600	0	0	0	0	0	0	
6.	pfrg	-ive	-	2240	0	0	0	0	0	0	
7.	pfrg	-ive	-	2053	0	0	0	0	0	0	
8.	pfrg	-ive	-	11200	0	0	0	0	0	0	
9.	pfr	-ive	-	2800	0	0	0	0	0	0	
10.	pfr	-ive	-	4000	250	0	0	0	0	0	
11.	pfrg	-ive	PHC	720	0	0	0	0	0	0	
12.	pfr	-ive	Talegram	2080	0	0	0	0	0	0	
13.	pfrg	-ive	-	1813	0	0	0	0	0	0	
14.	pfr	-ive	-	1013	0	0	0	0	0	0	
15.	pfrg	-ive	-	1466	0	0	0	0	0	0	
16.	pfr	-ive	-	2480	0	0	0	0	0	0	

Period of Study - June to November '1993

recorded during the study period. Results revealed no adverse effect on the above mentioned species (Table 6). Similarly, no harmful effect of biocide spray was recorded against domestic animals, aquatic stages of other useful animals like frog tadpoles, notonectid bugs and beetles.

Impact on malaria transmission: Blood smears from patients reporting fever at PHC, were examined regularly. This activity provided inter-departmental co-operation to the PHC staff. Timley examinations of blood smears further helped to combat this diseases.

From March to December, 1993, a total of 934 passive blood smears were examined. In these 61 were found positive for Pv, 10 for Pf and only 1 showed mixed infection. The SPR was found 6.6 per cent. These results also showed low prevalence of malaria during 1993.

Chloroquine resistance test in P. falciparum: In-vivo chloroquine sensitivity tests (28 days) as per WHO recommendation were carried out in two PHCs namely Jalalabad and Talegram of district Farrukhabad during June to November 1993. A total of 16 cases were selected for the study. The tests were conducted with 1500 mg adult dose of chloroquine. Children were given the proportionate doses. Out of 16 cases, only 2 cases showed parasite (asexual) in their blood while rest of the 14 cases did not show any parasite on any day of observation (Table 7). Since, the study is in progress, no conclusion could be drawn regarding the status of drug resistance in the area.

(V) NADIAD, KHEDA DISTRICT, GUJARAT

Parasitological studies

Parasitological studies in Nadiad taluka: Since 1992, from canal irrigated area of Nadiad taluka, five villages were taken to study relapse pattern in P. vivax and chloroquine sensitivity in P. falciparum. The parasitological data of villages for 1993 is presented in Tables 1 and 2. SPR in these villages ranged between 4.7 - 12.9. Due to presence of functional PHC and private practitioner in village Pij, BSC and SPR were found to be low. From Table 2 it is evident that prevalence of P. vivax is more than P. falciparum in this area, except during January and February.

TABLE 1: NADIAD: VILLAGEWISE PARASITOLOGICAL DATA OF STUDY AREA

Village	Population	BSE	Positive				SPR	API
			Pv	Pf	Mix	TOTAL		
1. Tundel	3375	650	66	15	2	83	12.8	24.6
2. Pij	6825	405	15	4	0	19	4.7	2.8
3. Bamroli	5316	1146	99	18	3	120	10.5	22.6
4. Davda	3426	710	58	29	5	92	12.9	26.8
5. Dantali	2986	685	59	18	1	78	11.4	26.1
Total	21928	3596	297	84	11	392	10.9	17.9

Study carried out till September '93

TABLE 2: NADIAD: MONTHWISE PARASITOLOGICAL DATA OF STUDY AREA

Month	BSE	Positive				SPR	SfR
		Pv	Pf	Mix	Total		
Jan	196	1	8	0	9	4.6	4.1
Feb	252	4	3	1	8	3.2	1.6
Mar	239	10	2	0	12	5.0	0.8
Apr	234	17	9	0	26	11.1	3.8
May	285	32	0	1	33	11.6	0.3
Jun	240	28	1	0	29	12.1	0.4
Jul	709	26	1	0	27	3.8	0.1
Aug	899	74	22	4	100	11.1	2.9
Sep	542	105	38	5	148	27.3	7.9
Total	3596	297	84	11	392	10.9	2.6

Relapse pattern in P. vivax : The study on relapse pattern in P. vivax was undertaken in 5 villages, out of which cases detected in two villages were administered only 600 mg chloroquine, in the third village patients were treated with 600 mg chloroquine along with 50 mg pyrimethamine and in fourth and fifth villages radical treatment was given according to NMEP drug policy. Follow-up blood smear collection of each case was done every month and also if there was a complaint of fever. The results for January '93 to December '93 are presented in Tables 3A-C. It was observed that there was no significant difference between relapse rate with chloroquine (13.92%) and chloroquine + pyrimethamine (14.29%) treated cases whereas cases receiving radical treatment as per NMEP drug policy showed low rate of relapse (4.49%) which reflects the efficacy of Primaquine. Only one case each from chloroquine and chloroquine + pyrimethamine drug regimen showed second relapse. In both the drug regimens high relapse was observed during 30-90 days after primary infection. The studies confirm that five day radical treatment in case of P. vivax is effective in preventing relapse in 95.5% cases.

Chloroquine resistance in P. falciparum in villages of Nadiad: During the period from January '93 to September '93, a total of 72 cases were studied as per Rieckmann's method (Table 4) and 5.6 per cent cases were found resistant to chloroquine at 1500 mg adult dose.

TABLE 3: NADIAD: RELAPSE RATE IN P. VIVAX

A. Treated with Chloroquine only

No. of relapses													
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Per cent relapses
(0)	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	(2)	0	0	1	0	0	0	0	0	0	0	1	50.00
		(6)	0	0	0	0	0	0	0	0	0	0	0.00
			(4)	0	0	0	1	0	0	0	0	1	25.00
				(11)	1	3	1	0	0	0	0	5	45.45
					(9)	0	2	0	0	0	0	2	22.22
						(8)	0	0	1	0	0	1	12.50
							(10)	0	0	0	0	0	0.00
								(29)	1	0	0	1	3.45
									(0)	0	0	0	0.00
										(0)	0	0	0.00
											(0)	0	0.00
									79			11	13.92

Total cases = 79; Relapse cases = 11; % relapse = 13.92
In parentheses are the number of cases of primary attack.

(Contd.)

TABLE 3 (Contd.)

B. Treated with Chloroquine and Pyrimethamine

No. of relapses													Per cent
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	relapses
(1)	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	(1)	0	0	0	0	0	0	0	0	0	0	0	0.00
		(3)	0	0	0	0	0	0	0	0	0	0	0.00
			(4)	0	1	0	0	0	1	0	0	2	50.00
				(7)	0	1	1	0	1	0	0	3	42.86
					(3)	0	1	0	0	0	0	1	33.33
						(4)	0	0	0	0	0	0	0.00
							(10)	0	0	0	0	0	0.00
								(9)	0	0	0	0	0.00
									(0)	0	0	0	0.00
										(0)	0	0	0.00
											(0)	0	0.00
									42			6	14.29

Total cases = 42; Relapse cases = 6 ; % relapse = 14.29
In parentheses are the number of cases of primary attack.

C. Treated with Chloroquine and Primaquine

No. of relapses													Per cent
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	relapses
(0)	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	(0)	0	0	0	0	0	0	0	0	0	0	0	0.00
		(1)	0	0	0	0	1	0	0	0	0	1	100.00
			(8)	0	0	0	1	0	0	0	0	1	12.5
				(12)	1	0	0	0	0	0	0	1	8.33
					(11)	0	0	0	0	0	0	0	0.00
						(6)	0	0	0	1	0	1	16.7
							(12)	0	0	0	0	0	0.00
								(39)	0	0	0	0	0.00
									(0)	0	0	0	0.00
										(0)	0	0	0.00
											(0)	0	0.00
									89			4	4.49

Total cases = 89; Relapse cases = 4; % relapse = 4.49
In parentheses are the number of cases of primary attack.

TABLE 4: NADIAD: CHLOROQUINE RESISTANCE IN P. FALCIPARUM IN NADIAD TALUKA (JANUARY - SEPTEMBER '93)

Cases studied - 72

Response	No. of cases	Per cent
R I	3	75 (4.2)
R III	1	25 (1.4)
Total	4(5.6)	

Figures in parentheses are percentages out of total cases studied

TABLE 5 : NADIAD : PARASITOLOGICAL DATA OF STUDY VILLAGES (PHC BUHARI) IN VALOD TALUKA, DISTRICT SURAT

Villages	Pop.	1991					1992					1993				
		BSE	Pos.	Pf	SPR	SfR	BSE	Pos.	Pf	SPR	SfR	BSE	Pos.	Pf	SPR	SfR
Valod	11392	2773	523	142	18.86	5.12	2355	170	35	7.22	1.49	4543	624	427	13.73	9.40
Mordevi	1743	340	76	36	22.35	10.59	238	23	4	9.66	1.68	555	127	106	22.88	19.10
Kanjod	1275	129	27	4	20.93	3.10	58	11	3	18.96	5.17	167	44	31	26.35	18.56
Ranveri	1877	179	51	8	28.49	4.47	93	21	4	22.58	4.30	212	43	26	20.28	12.26
Bhimpur	1350	339	44	6	12.98	1.77	393	12	3	3.05	0.76	270	21	16	7.78	5.92
Kumbiya	975	220	58	21	26.36	9.54	178	13	2	7.30	1.12	355	74	52	20.84	14.65

Detection of chloroquine resistance in P. falciparum in certain parts of Gujarat: With the spread of chloroquine-resistant P. falciparum malaria in Gujarat, Rajasthan and Maharashtra states, it is important to delimit chloroquine resistant foci in Gujarat. The present study is undertaken to identify and map RI, RII and RIII levels of resistance in endemic districts of Gujarat and to develop alternative drug policy for the control of resistant strains.

Surat is one of the endemic district in Gujarat state and accounts for 20.94% of all malaria cases and 33.4% of P. falciparum cases recorded in Gujarat. On the basis of P. falciparum incidence, villages of Buhari PHC were selected for present study (Table 5). Rieckmann's in-vivo method is being followed for detection of chloroquine resistance. Fever surveys were carried out in order to find P. falciparum positive cases with ring stages (Table 6). Patients with sufficient parasitaemia were followed for 7 days during the study. A total of 42 cases were followed during November-December '93 and S/RI (73.81%), S/RI late (16.67%), RI early/RII (2.38%) and RIII (7.14%) resistant falciparum cases were observed (Table 7). The

TABLE 6: NADIAD: FEVER SURVEY IN STUDY VILLAGES OF SURAT DISTRICT (NOVEMBER -DECEMBER '93)

Villages	Pop.	BSE	Pos.	Pf	Mix	SPR	SfR	%Pf
Valod	4252	240	106	9	9	44.2	42.9	97.2
Kanjod	800	19	7	6	0	36.8	31.6	85.7
Ranveri	450	4	0	0	0	0.0	0.0	0.0
Mordevi	850	55	32	30	1	58.2	56.4	96.9
Bhimpur	650	6	4	4	0	66.7	66.7	100.0
Modat	250	4	1	1	0	25.0	25.0	100.0
Kumbiya	675	24	14	14	0	58.3	58.3	100.0
Total	7927	352	164	149	10	46.6	45.2	96.9

TABLE 7: NADIAD: DIFFERENT DEGREE OF RESPONSE TO CHLOROQUINE TREATMENT SHOWN BY P. FALCIPARUM IN SURAT DISTRICT

Response	No. of cases	Percentage
S/RI*	31	73.81
S/RI late	7	16.67
RI early/RII	1	2.38
RIII	3	7.14

* Patients negative for malarial parasites on day 2 after treatment

TABLE 8 : NADIAD : LABOUR SURVEY IN VALOD VILLAGE OF SURAT DISTRICT

Fever cases					Nonfever cases					Total				
BSE	POS.	Pf	SPR	Pf%	BSE	POS.	Pf	SPR	Pf%	BSE	POS.	Pf	SPR	Pf%
54	7	5	13.0	71.4	118	10	9	8.5	90.0	172	17	14	9.9	82.3

TABLE 9 : NADIAD : PARASITOLOGICAL DATA OF INDICATOR VILLAGES IN MAHI RIVER PROJECT AREA

ROCKY	Villages situated on the bank							Villages situated 2 km away from the river						
Year	Pop.	BSE	Pos.	Pf	SPR	SfR	%Pf	Pop.	BSE	Pos.	Pf	SPR	SfR	%Pf
1991	2607	777	109	52	14.03	6.69	47.71	3267	625	42	27	6.72	4.32	64.29
1992		637	17	10	2.67	1.57	58.82		831	25	7	3.00	0.84	28.00
1993*		637	162	111	25.43	17.42	68.52		599	84	53	14.02	8.85	63.09
SANDY														
1991	4001	1644	42	5	2.55	0.30	11.90	15616	3331	129	35	3.87	1.05	27.13
1992		1911	37	0	1.94	0.00	0.00		3936	123	9	3.12	0.23	7.32
1993*		2185	56	11	2.56	0.50	19.64		4056	127	19	3.13	0.47	14.96
TIDAL														
1991	3380	799	12	7	1.50	0.88	58.33	2340	386	21	13	5.44	3.37	61.90
1992		829	5	5	0.60	0.60	100.00		785	29	13	3.69	1.66	44.83
1993*		1120	15	9	1.34	0.80	60.00		460	9	3	1.96	0.65	33.33

* MRC+NMEP, Source : DMO, Nadiad.

study is in progress and will be extended in other parts of Surat district.

Spleen survey: A sample group of 124 children under 10 years age were examined for palpable spleen in village Valod, to determine proportion of palpable enlargement and degree of enlargement of spleen.The high spleen rate (12.1%) and average enlargement of spleen 1.8 indicate perennial transmission in this area.

Labour survey: Large-scale sugar cultivation and establishment of sugar factories attracts labours from different district as well as from other states to this area. 172 blood smears were collected and examined (Table 8). It is interesting to find that P. falciparum contributed more than 80% . Despite low SPR, Pf per cent was higher in afebrile than febrile cases through which transmission may take place in the local population.

Studies on malaria transmission potential downstream of Wanakbori weir on river Mahi in Kheda: This study is planned to investigate downstream effect of dam/weir on the malaria potential, season of transmission and vector prevalence in the villages along the river route. The river downstream to Wanakbori weir comprises of three stretches

(i) Exposed rocky bed (42.5 km),
(ii) River bed mainly sandy covered with discharge of storm water (40 kms) and
(iii) Stretch under tidal influence (72.5 km). A total of twelve villages, four in each strech, two on the bank of the river and two about 2 km away from the river have been selected on the basis of past malaria incidence (Table 9).

Epidemiological observations: Preliminary surveillance was carried out during October-December to collect baseline parasitological data (Table 10). Villages in the vicinity of the river in the rocky stretch were more malarious than other villages. However P. falciparum is predominant in all the villages. Villages 2 km away from the river have shown similar trends in SPR and SfR.

Entomological observations: In all, 7 anpoheline species were recorded from the villages situated at least 2 km away from the river, of which An. aconitus and An. tessellatus were absent in the riverine villages. An. culicifacies (66.13%) was dominant followed by An. subpictus (31.3%). This trend was reversed in the villages away from the river (Table 11). Man hour densities also reflected a definite trend with rocky river stretch providing maximum breeding potential for mosquitoes in general and An. culicifacies in particular. Evidently there was marked influence of tidal waters on the breeding of An. culicifacies (Table 12), but due to the availability of other sources within the village the density of total mosquitoes and anophelines as a

TABLE 10: NADIAD: RESULT OF PARASITOLOGICAL SURVEY IN THE VILLAGES OF MAHI RIVER PROJECT AREA

ROCKY	Villages situated on the bank								Villages situated 2 km away from the river							
Month	Pop.	BSE	Pos.	Pf	Mix	SPR	SfR	%Pf	Pop.	BSE	Pos.	Pf	Mix	SPR	SfR	%Pf
Oct'93	2607	77	49	19	5	63.63	31.17	48.98	3267	34	24	15	1	70.59	47.05	66.67
Nov		52	45	40	1	86.54	78.85	91.11		33	20	15	1	60.60	48.49	80.00
Dec		12	9	7	0	75.00	58.33	77.78		18	11	11	0	61.11	61.11	100.00
SANDY																
Oct	4001	39	1	1	0	2.56	2.56	100.00	15616	66	14	7	1	21.21	12.12	57.14
Nov		27	7	4	1	25.92	18.52	71.43		27	8	6	0	29.63	22.22	75.00
Dec		5	3	2	0	60.00	40.00	66.67		49	3	3	0	6.12	6.12	100.00
TIDAL																
Nov	9733	14	6	4	2	42.86	42.86	100.00	3905	8	2	2	0	25.00	25.00	100.00
Dec		20	3	2	0	15.00	10.00	66.67		14	4	4	0	28.57	28.57	100.00

TABLE 11: NADIAD: COMPOSITION OF ANOPHELINES IN MAHI RIVER PROJECT AREA

Sl. no.	Species	On the bank				2 Km. away			
		Oct	Nov	Dec	Total	Oct	Nov	Dec	Total
1.	An. culicifacies	715 (58.03)	1179 (72.55)	375 (65.33)	2269 (66.13)	76 (9.94)	34 (7.08)	64 (19.57)	174 (11.07)
2.	An. subpictus	506 (41.07)	419 (25.78)	149 (25.95)	1074 (31.30)	660 (86.38)	401 (83.54)	167 (51.07)	1228 (78.16)
3.	An. annularis	9 (0.73)	26 (1.60)	46 (8.01)	81 (2.36)	3 (0.39)	1 (0.20)	9 (2.75)	13 (0.82)
4.	An. stephensi	1 (0.08)	1 (0.06)	4 (0.09)	6 (0.17)	22 (2.87)	41 (8.54)	86 (26.29)	149 (9.48)
5.	An. barbirostris	1 (0.08)	-	-	1 (0.03)	1 (0.13)	-	-	1 (0.06)
6.	An. tessellatus	-	-	-	-	1 (0.13)	3 (0.62)	-	4 (0.25)
7.	An. aconitus	-	-	-	-	1 (0.13)	-	1 (0.30)	2 (0.12)
	Total	1232	1625	574	3431	764	480	327	1571

Figures in parentheses are the per cent values out of total collection

whole was less affected. Preliminary larval surveys yielded six anopheline species and An. culicifacies breeding was recorded from drain, river and seepage pools (Table 13).

TABLE 12: NADIAD: MAN HOUR DENSITIES IN VILLAGES OF MAHI RIVER PROJECT AREA

Attribute	Month	On the river bank				2 km away from the river			
		Rocky	Sandy	Tidal	Mean	Rocky	Sandy	Tidal	Mean
Total mosquitoes	Oct	117.00	94.25	78.00	96.41	46.75	68.50	75.75	63.67
	Nov	133.50	154.50	100.00	129.33	30.25	65.50	39.00	44.91
	Dec	68.00	47.25	21.75	45.65	20.75	23.75	38.75	27.75
Total anophelines	Oct	115.75	92.00	76.50	94.75	40.00	65.25	71.75	59.00
	Nov	132.25	154.50	99.00	128.58	25.25	54.50	39.00	39.58
	Dec	66.75	45.25	20.50	44.16	14.00	16.75	33.00	21.25
Anopheles culicifacies	Oct	72.00	68.50	20.00	53.50	5.25	8.25	1.25	4.91
	Nov	102.25	107.00	69.00	92.75	4.50	3.75	0.25	2.83
	Dec	44.00	35.50	6.25	28.58	2.75	0.75	2.75	2.08

Man hour densities are based on indoor (4 cattlesheds + 4 human dwellings) resting collection from two villages in each category of river stretch.

TABLE 13: NADIAD: SPECIES SPECIFIC BREEDING SOURCES IN MAHI RIVER PROJECT AREA

Species	Seepage pool	Well	Ditch	Drain	River	Pond
An. culicifacies	+			+	+	
An. stephensi	+	+				
An. nigerrimus	+					
An. subpictus			+	+		+
An. barbirostris					+	
An. annularis					+	

+ denotes the presence of the species.

TABLE 14: NADIAD: PARASITOLOGICAL DATA OF VILLAGES IN THE SARDAR SAROVAR (NARMADA) PROJECT AREA

Villages	Pop.	1991					1992					1993				
		BSE	Pos.	Pf	SPR	SfR	BSE	Pos.	Pf	SPR	SfR	BSE	Pos.	Pf	SPR	SfR
Gora	1082	463	107	27	23.11	5.83	711	83	11	11.67	1.55	517	66	19	12.77	3.68
Vaghadia	563	267	82	35	30.71	13.1	344	57	16	16.57	4.65	283	38	18	13.43	6.36
Mokhadi	723	87	13	5	14.94	5.75	314	43	10	13.69	3.18	84	15	1	17.86	1.19
Surpan	309	75	11	5	14.67	6.67	197	23	7	11.68	3.55	84	10	2	11.90	2.38
Katkhadi,	334	12	0	0	00.00	0.00	81	9	2	11.11	2.47	9	4	3	44.44	33.33
Limdi	587	139	22	11	15.83	7.91	231	21	7	9.09	3.03	173	21	9	12.14	5.20
Vadgam	1656	164	24	6	14.63	3.66	197	26	8	13.20	4.06	133	21	10	15.79	7.52
Naghatpur	1569	355	78	21	21.97	5.92	655	74	10	11.30	1.53	492	45	17	9.15	3.46
Navagam	525	289	78	35	26.99	12.1	545	44	10	8.07	1.83	141	18	6	12.77	4.26
Navagamdam	2670	424	103	15	24.29	3.54	2087	124	34	5.94	1.63	2173	80	24	3.68	1.10
Undva	1570	823	219	71	26.61	8.63	773	131	14	16.95	1.81	385	48	26	12.47	6.75
Khadagda	1975	756	159	36	21.03	4.76	936	149	31	15.92	3.31	1043	108	44	10.35	4.22
Amadla	1436	644	117	22	18.17	3.42	732	109	27	14.89	3.69	741	64	24	8.64	3.24
Dhamadra	1359	690	128	33	18.55	4.78	728	121	28	16.62	3.85	819	62	33	7.57	4.03
Vadi	868	326	67	15	20.55	4.60	362	31	5	8.56	1.38	389	37	16	9.51	4.11
Zaria	972	573	97	30	16.93	5.24	737	64	12	8.68	1.63	513	44	31	8.58	6.04
Kevadia	1145	564	144	57	25.53	10.1	625	126	33	20.16	5.28	403	66	24	16.38	5.96
Kothi	1276	610	151	52	24.75	8.52	781	130	28	16.65	3.59	516	64	20	12.40	3.88
Gabhana	684	367	105	39	28.61	10.6	640	134	38	20.94	5.94	393	58	30	14.76	7.63
Total	21303	7628	1705	515	22.35	6.75	11676	1499	331	12.84	2.83	9291	869	357	9.35	3.84

Source : Medical Officer, Project hospital, Kevadia colony.

Malaria transmission dynamics in the Sardar Sarovar (Narmada) Project area in Bharuch district, Gujarat: Sardar Sarovar Project dam site and villages in its vicinity had shown high malaria incidence with predominance of P. falciparum (Table 14) in spite of control measures implemented by Sardar Sarovar Narmada Nigam Limited (SSNNL) and J.P. Associate Hospital at dam site. The present study aims to strengthen the existing antimalaria infrastructure of SSNNL through regular monitoring and finding other factors responsible for high malaria prevalence with the prime objectives to study transmission dynamics of malaria in catchment and command area and to develop sensitive and dependable epidemiological indicator for forecasting outbreak of malaria and to suggest appropriate remedial measures.

Epidemiological observations: Preliminary fever surveys were carried out in 13 villages, 3 in command area, 6 located downstream of Narmada river and 4 away from Narmada project during December, 1993 to obtain baseline data. From Table 15

TABLE 15: NADIAD: RESULTS OF PARASITOLOGICAL SURVEY IN THE VILLAGES OF SARDAR SAROVAR (NARMADA) PROJECT AREA

Village	Pop.	BSE	Pos.	Pf	SPR	SfR	%Pf
COMMAND AREA							
Naghatpur	1569	6	0	0	0.00	0.00	0.00
Undva	1570	2	2	2	100.00	100.00	100.00
Shamsherpura	446	2	1	1	50.00	50.00	100.00
Total	3585	10	3	3	30.00	30.00	100.00
DOWNSTREAM AREA							
Vaghadia	563	2	1	1	50.00	50.00	100.00
Navagam	525	3	0	0	0.00	0.00	0.00
Gabhana	684	2	0	0	0.00	0.00	0.00
Kothi	1276	4	0	0	0.00	0.00	0.00
Limdi	587	1	1	1	100.00	100.00	100.00
Kevadia	1145	6	2	2	33.33	33.33	100.00
Total	4780	18	4	4	22.22	22.22	100.00
RIVERINE AREA (Other than Narmada river)							
Khadagda	1975	8	0	0	0.00	0.00	0.00
Zaria	972	3	1	1	33.33	33.33	100.00
Amadla	1436	4	0	0	0.00	0.00	0.00
Vadi	868	6	1	1	16.67	16.67	100.00
Total	5251	21	2	2	9.52	9.52	100.00
Grand Total	13616	49	9	9	18.37	18.37	100.00

TABLE 16: NADIAD: COMPOSITION OF ANOPHELINES IN SSP AREA

S. No.	Species	Down stream of Narmada		On Narmada main canal		Dyke pond area		Other riverine		Total	
1.	An. culicifacies	1152	(88.00)	645	(93.20)	254	(65.12)	220	(94.82)	2271	(86.58)
2.	An. stephensi	4	(0.30)	-	-	-	-	-	-	4	(0.15)
3.	An. annularis	46	(3.51)	16	(2.31)	71	(18.20)	5	(2.15)	138	(5.26)
4.	An. subpictus	60	(4.58)	20	(2.89)	15	(3.84)	2	(0.86)	97	(3.69)
5.	An. turkhudi	18	(1.37)	1	(0.14)	-	-	1	(0.43)	20	(0.76)
6.	An. jamesii	9	(0.68)	1	(0.14)	-	-	-	-	10	(0.38)
7.	An. fluviatilis	8	(0.61)	6	(0.86)	48	(12.30)	3	(1.29)	65	(2.47)
8.	An. vagus	3	(0.22)	-	-	-	-	-	-	3	(0.11)
9.	An. splendidus	8	(0.61)	1	(0.14)	-	-	1	(0.43)	10	(0.38)
10.	An. nigerrimus	1	(0.07)	-	-	-	-	-	-	1	(0.03)
11.	An. barbirostris	-	-	1	(0.14)	-	-	-	-	1	(0.03)
12.	An. pallidus	-	-	1	(0.14)	-	-	-	-	1	(0.03)
13.	An. theobaldi	-	-	-	-	2	(0.51)	-	-	2	(0.07)
	Total	1309		692		390		232		2623	

Figures in parentheses are the percentages.

it is apparent that P. falciparum was predominant in most of the villages. However, malaria incidence were low, which may be due to seasonality of transmission.

Entomological observations: Adult mosquito collections made in the villages around the project site revealed the presence of 13 anopheline species (Table 16). An. culicifacies was predominant (> 65%) in all the 4 categories of villages viz. downstream of Narmada river (2), on the Narmada main canal (2), dyke pond area (1) and situated on minor river other than Narmada. Very high density of An. culicifacies (> 190 per man hour) was recorded in all the villages with the exception of village in the vicinity of dyke pond area, indicating tremendous breeding potential provided by Narmada river and other breeding sources in the area (Table 17). An. fluviatilis was commonly encountered but was most abundant in the dyke pond village owing to the presence of favourable breeding source (Table 17). Larval samples collected from river, rice fields in the river bed or on the bank and hoof prints revealed the breeding of 5 species (Table 18). Profuse breeding of An. culicifacies was observed in river and rice fields.

Other Entomological studies

Field evaluation of Neem oil as mosquito repellent: To test the efficacy of neem oil as mosquito repellent, all-night man biting mosquito collections were carried out in Galteshwar, Lingda and Kanjari villages of Kheda district during the months of March and April 1993. Galteshwar (pop. 252) is situated on the bank of perennial river Mahi and the mosquito fauna was dominated by An. culicifacies (68%). Lingda (pop. 3758) is a highly irrigated

TABLE 17: NADIAD: MAN HOUR DENSITY OF MOSQUITOES IN SSP AREA

Sr. No.	Attribute	Downstream of Narmada river	On Narmada main canal	Dyke pond area	Other riverine	Mean
1.	Total mosquitoes	336.00	205.25	107.75	230.00	219.75
2.	Total Anophelines	314.00	204.25	97.50	225.00	210.18
3.	An. culicifacies	279.50	192.50	63.50	214.00	187.37
4.	An. fluviatilis	1.75	1.50	12.00	3.00	4.56

TABLE 18: NADIAD: HABITATWISE SPECIES COMPOSITION IN SSP AREA

Species	River	Rice fields	Hoof prints
An. culicifacies	42 (77.78)	12 (100)	-
An. annularis	5 (9.25)	-	-
An. jamesii	2 (3.70)	-	-
An. splendidus	-	-	1 (100)
An. theobaldi	5 (9.25)	-	-
Total	54	12	1

village and rice is the main crop cultivated twice in a year. Mosquito fauna was dominated by Cx. quinquefasciatus (24%), An. tessellatus (21%), Ma. uniformis (21%) and Ae. taeniorhynchoides (8%). Kanjari is a semi-urban type of a village (pop. 11000) and the fauna was dominated by Cx. quinquefasciatus (97%).

Neem oil (marketed by Shree Baidyanath Ayurved Bhavan P. Ltd., Nagpur) was mixed (v/v) in coconut oil (Parachute brand) to get 0.5%, 1% and 2% concentrations and 5 ml of each was applied evenly on all the exposed body parts of three volunteers. Coconut oil was similarly applied on one volunteer to serve as control. During 10 nights, all-night man biting collections were also made using an untreated (normal) human bait to know the rate of biting mosquitoes. Results for all the three villages were pooled, analysed and are presented in Tables 19 and 20. It can be seen that 2% neem oil provides maximum protection against the malaria vectors An. culicifacies (98%) and An. fluviatilis (89%). Biting rates of An. culicifacies on the volunteers treated with all the three concentrations of neem oil were significantly less than that on the control baits treated only with coconut oil. Similarly, neem oil (0.5-2%) provided varying degree of protection against other species viz. Cx. quinquefasciatus (43-76%), Cx. vishnui gr. (45-80%), Ae. taeniorhynchoides (62-86%) and Ma. uniformis (58-87%). Biting rates of anophelines in general on human volunteers ranged between 4-7 /bait/night at 2 and 0.5% concentration of neem oil respectively as against 15 /bait/night on control baits. 2% concentration of neem oil provided 77% protection against the biting of all mosquitoes.

Impact of agro-chemicals on mosquito larval population in rice-fields: A project has been taken up in collaboration with the Main Rice Research Station (MRRS) of Gujarat Agricultural University, at Nawagam in district Kheda to study the impact of agro-chemicals on mosquito larval population in rice fields. The

TABLE 19: NADIAD: MAN BITING RATE OF MOSQUITOES ON HUMAN VOLUNTEERS APPLIED WITH NEEM OIL AND COCONUT OIL

Mosquito species	Concentrations of neem oil(%)			Coconut oil (control)
	0.5	1	2	
An. culicifacies	0.83± 1.75 *	0.17± 0.39 *	0.08± 0.29 *	4.08± 4.68
An. fluviatilis	0.42± 1.16	0.25± 0.62 *	0.08± 0.29 *	0.75± 1.05
Cx. quinquefasciatus	30.50±49.56	20.67±27.28	12.67±18.37	53.83±148.50
Cx. vishnui gr.	1.58± 5.18	1.17± 3.74	0.58± 1.08	2.92± 4.85
Ae. taeniorhynchoides	2.42± 6.04	0.92± 1.56	0.92± 1.56	6.50± 14.57
Ma. uniformis	3.83± 6.86	3.33± 4.87	1.17± 2.04	9.25± 15.70
Total anophelines	7.17±14.87	5.00±14.53	4.75± 8.64 *	15.17± 17.54
Total culicines	39.50±58.50	26.58±27.77	15.33±19.08	73.58±148.06

Mean mosquitoes/man/night+SD based on the collections for 12 nights on one bait each. Means were compared with control using t-test (df = 11, * : $p < 0.05$).

effect of application of different agro-chemicals such as fertilizers, oil cakes and different pesticides, synthetic as well as plant based (herbal) on the mosquito larval population was studied during the monsoon season. Larval population in experimental and control rice plots was monitored on weekly basis. Immatures were brought to the laboratory at Nadiad and reared to adults for species identification. Impact of the application of agro-chemicals on the population of important predators of mosquito larvae was also assessed by MRRS scientists and their report is awaited. Due to erratic monsoon this year, proper irrigation of all the experimental rice plots was not possible hence, regular monitoring could not be done. Since, only one crop of rice during monsoon season is cultivated at MRRS, observations will be continued during the next two years.

Following treatments were given in experimental rice plots.

Oil cakes : Neem, Varakhada, Karanj, Castor, Mahuva, Datura and Mustard.

Herbal insecticides : RD-9 (ITC), Margocide (NCL), Parasmani (local neem based insecticide), emulsified neem oil, neem seed and neem leaves suspensions.

Synthetic insecticides : Chlorpyriphos (25 EC), Quinalphos (25 EC), Monocrotophos (36 w/w), Phorate (10 G), Carbofuran (3 G) and Acephate (75 SP).

Biological control

Isolation of microbial pathogens: Studies pertaining to entomopathogens have yielded encouraging results. Four bacterial isolates obtained during 1992 have been identified as B. sphaericus H1 and H5, B. pumilus and B. thuringiensis by Pasteur Institute, Paris. Their activity against mosquito larvae were confirmed and LC_{50} of each strain is given in Table 21.B. pumilus was found inactive. Further, altogether 31 samples of water (3), soil (14), water hyacinth root (1) and diseased/dead mosquito larvae (13) collected from irrigation drain, sewage treatment pond, river bed pool and cess pool were processed for isolation of bacillus strains. One bacillus strain obtained from dead mosquito larvae was observed pathogenic against anophelines as well as culicine larvae. The strain was passed through 25 successive transfers on Barjac agar media and 8th, 16th and 25th generations showed pathogenicity against Ae. aegypti larvae.

TABLE 20: NADIAD: RELATIVE PROTECTION PROVIDED BY NEEM OIL FROM THE BITING OF MOSQUITOES

Mosquito species	Concentrations of neem oil(%)			Coconut oil (control)
	0.5	1	2	
An. culicifacies	79.65 (10)	96.07 (2)	98.03 (1)	- (49)
An. fluviatilis	45.33 (5)	66.67 (3)	89.34 (1)	- (9)
Cx. quinquefasciatus	43.34 (366)	61.61 (248)	76.48 (152)	- (646)
Cx. vishnui gr.	45.70 (19)	60.13 (14)	80.06 (7)	- (35)
Ae. taeniorhynchoides	62.92 (29)	86.00 (11)	86.00 (11)	- (78)
Ma. uniformis	58.59 (46)	63.89 (40)	87.45 (14)	- (111)
Total anophelines	52.77 (86)	67.01 (60)	68.67 (57)	- (182)
Total culicines	46.32 (474)	63.88 (319)	79.16 (184)	- (883)
Total mosquitoes	47.41 (560)	64.41 (379)	77.37 (241)	- (1065)

Values are per cent protection calculated using the formula : per cent protection = [(Nc - Nt) / Nc] x 100, where Nc and Nt are the number collected of coconut and neem oil applied baits respectively. Figures in parentheses are the total specimens collected.

TABLE 21: NADIAD: LOCAL ISOLATES OF MOSQUITO PATHOGENS

S. No.	MRC code	Name of the strain	LC 50 *	Breeding habitat	Source
Bacteria					
1.	9201	B. sphaericus H1	3.51×10^{-6}	oxidation pond	diseased larvae
2.	9202	B. pumilus	inactive	rice field	soil
3.	9203	B. sphaericus H5	0.75×10^{-6}	cesspool	dead larvae
4.	9204	B. thuringiensis	3.47×10^{-6}	oxidation pond	diseased larvae
5.	9301	B. Sphaericus H1	0.9×10^{-5}	oxidation pond	dead larvae
Fungus					
6.	u9	Geotrichum candidum **	-	oxidation pond	soil

* As per the Institute Pasteur, Paris
** Identified by International Mycological Institute, UK

TABLE 22: NADIAD: COMPOSITION OF MEDIA FOR B. SPHAERICUS, FINAL pH, PER CENT SPORULATION, VIABLE COUNT AND BIOMASS YIELD

Strain	Media	Amount of ingredient (gm/l)			Final pH	Viable count (sp./ml)	% sporulation	Biomass yield (gm/l)
		Rajma	Gram flour	Rice bran				
9002	A	20	30	-	7.0	2.1×10^{6}	31.9	20.4
	B	20	-	20	8.5	7.5×10^{6}	43.3	6.4
2362	A	20	30	-	7.5	2.6×10^{6}	25.6	11.8
	B	20	-	20	8.5	3.8×10^{6}	63.9	6.4

Defated powder of Rajma and rice bran was used.

A total of 25 samples of soil (13), water (3) and dead larvae (9) collected from cess pool and oxidation ponds were processed for isolation of fungal pathogens. Twenty two fungal colonies were obtained and screened. One of these colonies has exhibited activity against anopheline and Aedes larvae. This strain has been identified by International Mycological Institute, Surrey (UK) as Geotrichum candidum Link - a member of ascomycetes order Endomycetales.

Effect of strain and medium variation on mosquito toxin production by B. sphaericus: Study is aimed to develop media giving high yield of mosquito toxin and biomass of two bacilli, B. sphaericus 9002 (a local isolate) and B. sphaericus 2362 (received from Pasteur Institute, Paris). Ingredient containing adequate amount of protein, available locally such as gram flour, rice bran, rajma with basal medium $MgSO_4$ $7H_2O$ (500 mg/l), $MnSo_4$ $7H_2O$ (100 mg/l) and $CaCl_2$ (100 mg/l) were used. Two media A and B (Table 22) were formulated. Media B yielded higher viable count and spores. However, in case of both the strains, biomass harvested from media A was greater than B.

Health education

Education for consciousness of malaria in school children and their parents was imparted through health camp arranged in science exhibition. The exhibition was organised by City Primary Education Committee, Anand from 5-7th February 1993. Ten NSS volunteers of Anand Arts College, Anand were trained for communication of malaria awareness. The volunteers participated actively during exhibition at Anand. Approximately 12,700 children and parents were made aware of malaria and its bio-environmental control strategy. During health camps, 45 slide shows were also arranged alongwith lectures on malaria parasites, mosquito breeding sites, chemotherapy and alternative control strategy.

(VI) NATIONAL CAPITAL TERRITORY OF DELHI

Master action plan for the control of mosquitoes in NCT of Delhi

This is ongoing study since 1989. Initially geographical reconnaissance (GR) was carried out to identify and map the breeding sites of mosquitoes covering an area of >1600 km and about 9.5 million population. Permanent water bodies suitable for establishment of larvivorous fish hatcheries were also identified. During the year 1990 adult density of mosquitoes were monitored in 720 localities in order to correlate the data of immature and adult density. Same localities were monitored for the incidence of malaria in the year 1991 to correlate malaria endemicity with adult density of mosquitoes. In 1992 incidence of malaria were monitored throughout NCT of Delhi for identification of core problem localities and results of this survey has been published in the Annual Report, 1992. The core problem localities were identified based on the point prevalence survey in different months, but true endemicity can only be established, if sampling method is used to cover localities for full transmission season. In view of this a statistical design is being prepared in collaboration with the Institute of Research in Medical Statistics (IRMS), Delhi and entomological and epidemiological data have to be collected for preparation of an action plan. Required information and data was given to IRMS sample size estimation for each stratum and preparation of experimental design is in progress.

Efforts are under way to analyze the data already collected and based on this, a paper on the mosquito and vector-borne disease control will be prepared for use by the implementing agencies.

Longitudinal studies on incidence of malaria in Cooperative group housing societies and notified and un-notified slums

Longitudinal studies were carried out in labour camps of Cooperative group housing societies and slum inhabitants to monitor incidence of malaria, prevalence of vector species and their breeding habitats.

Study sites: Four Cooperative Group Housing Societies located in Rohini labour complex sector 15 were selected for this study. These were Manav Vihar, Nav Vikas, Modern Apartment and Sur-air group housing society. Labour population 336 migrated from Rajasthan, Madhya Pradesh, Bihar and eastern U.P. was distributed in about 70 huts within the complex.

In addition to this notified slum in R.K. Puram Sector 12, un-notified slum in Rohini complex sector 16 and migrant slum population in Mahipalpur area was also monitored. The population living in these slums is usually engaged in construction, mining craftwork and development activities etc. It may be pointed out that co-operative group housing societies and other slums had floating population.

Entomological and epidemiological data was collected since August 1990 in group housing societies, while the data in other slums was collected only from August 1991 onwards.

Intensified antilarval measures and mass drug therapy undertaken by corporation and early case detection and treatment of positive cases by the Centre resulted in gradual reduction in the incidence of malaria in co-operative group housing societies of Rohini Sector - 15. In 1990 the man hour density (MHD) of anopheline was also high and varied from 10.1 to 80 (average 49.6) (Table 1), cases/000 were 282.7 which were reduced to 119.0 in 1991, 38.6 in 1992, and 17.8 in 1993. Similarly Pf/000 were reduced from 205.3 to 77.3 in 1991, 23.3 in 1992 and 2.9 in 1993. This clearly indicates that construction activities substantially contribute to the transmission of malaria in NCT of Delhi. Malaria associated with construction activities was mainly transmitted by An. culicifacies. The study also indicates descending trend of malaria since 1990.

Similar trend of malaria was observed in un-notified slum of Rohini Sector-16 (Table-2). However, the intensity of the disease was quite high in comparison to group housing societies located in Sector 15 during the corresponding year. In 1991 the average SPR was 64.4 as against 32.7 in group housing societies. Similarly, the average SfR was 38.07 in un-notified slum of Sector-16 as against 21.3 in group housing societies. Cases/000 and Pf/000 were 135.9 and 80.2 respectively, as against 119.0 and 77.3 in Sector-15. Both man hour density and per cent proportion of An. culicifacies were high in comparison to Sector-15. The study identified a new foci of malaria in labour population which remained un-noticed by MCD health authorities. Cases/000 were reduced from 135.9 to 16.5 in 1992 and 11.77 in 1993. Similar reduction was observed in falciparum cases in 1993.

The predominant vector species was An. culicifacies. The breeding of this species was observed mainly in pools, ponds and canals near to Hyderpur water reservoir. Cement tanks in construction complex were supporting the breeding of An. stephensi which is also an efficient vector of urban malaria.

Results of labour migrant slums of Mahipalpur near Vasant Kunj revealed high incidence of malaria, though the intensity of the disease was comparatively low in comparison to labour settlement in construction complex. In this area illegal mining activities are going on and several stone quarries are formed

TABLE 1: DELHI: ENTOMOLOGICAL AND EPIDEMIOLOGICAL POOLED DATA OF COOPERATIVE GROUP HOUSING SOCIETIES OF ROHINI SECTOR-15

Month year	MHD vector species	MHD Culex	BSC	Pv	Pf	Mix	SPR	SfR	Cases/00	Pf/000
1990 *	49.6	38.1	218	25	69	1	43.5	31.6	282.7	205.3
1991	21.0	265.9	122	13	26	1	32.7	21.3	119.0	77.3
1992	13.5	191.9	64	5	8	0	20.3	12.5	38.6	23.8
1993	4.0	146.7	65	5	1	0	9.2	1.5	17.8	2.9

Population - 336; Hutments - 70; Area - 0.04 sq kms
* - August to December

TABLE 2: DELHI: MONTHWISE ENTOMOLOGICAL AND EPIDEMIOLOGICAL DATA OF UN-NOTIFIED SLUM OF ROHINI SECTOR - 16 (CLZ)

Year/ month	MHD Anopheline	MHD Culex	Epidemiological data							
			BSC	Pv	Pf	Mix	SPR	SfR	Cases/000	Pf/000
1991 *	9.8	22.6	394	104	147	3	64.4	38.07	135.97	80.20
1992	14.0	106.3	98	20	11	0	31.6	11.20	16.59	5.88
1993	2.83	41.6	138	18	4	0	15.9	2.89	11.77	2.14

Population - 1868; Area - 0.063 Sq km; Houses - 650
* - August to December

which get filled up with water during monsoon and support mosquito breeding. In certain cases digging is so deep that natural water comes out and such quarries become perennial in nature. Breeding of An. culicifacies, An. stephensi and An. annularis was observed in this area but An. culicifacies was found to be predominant. During 1991 the anopheline density species was ranging from 18 to 33 (average 24.6), cases/000 and Pf/000 were 75.8 and 52.1 respectively (Table 3). However in 1992, following outbreak of falciparum malaria in adjoining Vasant Kunj area, MCD authorities intensified their measures and both vector density and incidence of malaria were brought under control. In this area, there is overlapping population of An. culicifacies and An. stephensi and both are suspected vectors of malaria.

Results of notified slums located near R.K. Puram also revealed high incidence of malaria. In mosquito collections no specimen of An. culicifacies was encountered, all anopheline population consisted of An. stephensi. As observed in other sites incidence was higher in 1991 and timely detection and treatment of positive cases resulted in reduction of malaria (Table 4).

TABLE 3: DELHI: MONTHWISE ENTOMOLOGICAL AND EPIDEMIOLOGICAL DATA OF LABOUR MIGRANT SLUM OF MAHIPALPUR (NGZ. MCD)

Year/ Month	MHD Anophe-line	MHD Culex	Epidemiological data							
			BSC	Pv	Pf	Mix	SPR	SfR	Cases/000	Pf/000
1991 *	24.6	49.2	156	25	55	0	51.2	35.2	75.80	52.10
1992	17.1	87.1	76	6	8	0	18.42	10.5	13.27	7.58
1993	3.8	10.9	225	12	2	0	6.22	0.88	13.2	1.89

Population - 1055; Area - 0.035 Sq km; Houses - 650
* - August to December

TABLE 4: DELHI: MONTHWISE ENTOMOLOGICAL AND EPIDEMIOLOGICAL DATA OF NOTIFIED SLUM R.K. PURAM SECTOR - 12 (SZ, MCD)

Year/ Month	MHD Anophe-line	MHD Culex	MHD Aedes	Epidemiological data							
				BSC	Pv	Pf	Mix	SPR	SfR	Cases/000	Pf/000
1991 *	5.4	193.4	36.8	211	75	16	1	43.6	8.05	41.40	7.65
1992	3.0	75.5	12.5	77	11	2	0	16.88	2.59	5.85	0.9
1993	1.2	27.2	3.9	128	11	3	0	10.93	2.34	6.3	1.35

Population - 2221; Area - 0.075 Sq km; Houses - 700
* - August to December

Similarly, antilarval measures intensified in selected sites by MCD reduced vector density effectively. However, it was interesting to note that transmission is still maintained and marginal increase in both vivax and falciparum incidence has been observed. This is because of intera-domicile transmission as the breeding was observed mainly in ground and overhead tanks.

Longitudinal studies in selected construction and slum area revealed high incidence of malaria which remained un-noticed by the health authorities of the corporation. Study also revealed that malaria is associated with construction activities and also with the congregation of labour who come from endemic area. The vector density is built up especially in first phase of construction when lot of earth work is carried out and water is stored for curing and construction purpose. In notified slums located in town intera-domicile transmission is maintained as overhead tank and ground water tanks which are not mosquito proof are highly conducive for the breeding of An. stephensi.

The study also revealed high mosquito nuisance caused by Culex quinquefasciatus particularly in Rohini complex. The density of this species in Mahipalpur and R.K. Puram was moderate. The density of Aedes aegypti a vector of dengue and dengue hemorrhagic fever (DHF) was encountered only in R.K. Puram notified slum.

Field trials of biolarvicides in and around NCT of Delhi

Recently, two wettable formulation of biolarvicide from Russia viz. Spherix and Bactoculicide were imported to evaluate operational feasibility and efficacy in controlling mosquito population particularly of malaria and filaria vectors. Multicentric trials of these formulations were carried out in different parts of the country in early 1993 with an objective to evaluate its impact on immatures, adult mosquito density and incidence of malaria and filaria. Results of the trials carried out in Dehra village, of Dhaulana PHC, District Ghaziabad (U.P.) and Mahipalpur locality of circle no. 178, Najafgarh zone of Municipal Corporation of Delhi, the results are reported below.

Impact of spraying in Dehra village, Dhaulana PHC: Dehra village is located on left bank of upper Ganga canal in Dhaulana PHC, of district Ghaziabad (U.P.). The village consists of a population of about 6880 distributed in about 1500 houses. An. culicifacies is the principal vector of malaria and breeds in irrigation channels, minor drains, pools and ponds. Geographical reconnaissance (GR) carried out before spraying revealed that there are 23 pools, 6 ponds, 13 wells, 24 irrigation channels, 6 minor drains and 3 irrigation tri-butories distributed within a radius of 5 km. The village is endemic for malaria and main occupation of inhabitants is agricultural practices. All water

bodies of the village positive for mosquito breeding were sprayed with 1 gm/sq m spherix wettable formulation and re-application of biocide was carried out on appearance of III and IV instar larvae in each habitat throughout the study period.

Dhaulana village consists of about 9169 population and situated at about 7 kms away from Dehra village in same PHC. There are about 32 pools, 5 ponds, 15 wells, 25 minor irrigation channels and 11 drains. Mosquito density and incidence of malaria were comparable with Dehra village. No antilarval measures were taken in this village, however, 3 rounds of HCH spraying was carried out under NMEP.

Monthwise results of biolarvicide spraying in different habitats on culicine immatures is given in Table 5. The application of spherix @ 1 gm/sq m produced dramatic reduction in larval density within one week of application and 95-100% reduction in III and IV instar culicine larvae was maintained

TABLE 5: DELHI: LARVAL AND ADULT DENSITY IN VILLAGE DEHRA (EXPT.) AND DHAULANA (CONTROL) OF PHC DHAULANA, DISTRICT GHAZIABAD, UTTAR PRADESH

Month	Average density/dip		MHD Culex	
	Experimental	Control	Experimental	Control
Pre-density	117.0	111.86	912.0	863.0
Apr '93	2.3 * (95.9)	49.4	908.0 (9.2)	939.2
May	0.5 * (99.3)	57.2	254.5 (66.2)	707.5
Jun	1.5 * (96.7)	39.8	30.0 (91.0)	321.5
Jul	0.2 * (99.7)	57.2	22.2 (93.3)	309.2
Aug	0.0 * (100.0)	67.2	20.5 (91.2)	219.2
Sept	0.0 * (100.0)	20.5	19.7 (84.2)	116.7
Oct	0.0 * (100.0)	20.8	37.5 (74.9)	140.2
Nov	0.0 * (100.0)	40.2	57.5 (78.8)	267.2
Dec	0.0 * (100.0)	110.6	44.0 (81.6)	224.2
Jan '94	0.05 * (99.9)	51.5	24.2 (92.6)	291.7

* Indicates re-application of spherix; Figures in parentheses shows percentage protection

TABLE 6: DELHI: LARVAL AND ADULT ANOPHELIN DENSITY IN VILLAGE DEHRA (EXPT.) AND DHAULANA (CONTROL) OF PHC DHAULANA DISTRICT GHAZIABAD, UTTAR PRADESH

Month	Average density/dip		Man Hour Density			
			Anopheles		An. culicifacies	
	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Pre-density	4.0	7.2	246	184	229	175
Apr '93	2.0 (34.7)	5.2	266.7 (19.9)	233	248.5 (22.2)	223.5
May	1.8 (42.3)	5.3	143.2 (50.9)	203.2	124.2 (50.8)	176.5
Jun	2.03 * (53.6)	7.4	50.7 (65.7)	103.2	17.5 (40.9)	20.7
Jul	1.05 * (70.8)	6.1	246.7 (51.5)	355.5	64.2 (35.8)	70.0
Aug	0.7 * (75.8)	4.9	494.7 (28.1)	481.2	101.5 (2.3)	72.7
Sept	0.41 * (79.5)	3.4	423.7 (18.9)	365.7	77.0 (25.2)	72.0
Oct	0.4 * (86.4)	5.0	275.5 (31.7)	282.0	66.0 (44.2)	82.7
Nov	0.26 * (93.5)	6.7	341.7 (51.1)	488.7	238.2 (12.6)	190.7
Dec	0.5 * (86.8)	6.4	160.0 (7.5)	121.0	114.5 (2.5)	82.2
Jan '94	0.19 (90.3)	3.5	74.7 (36.8)	82.2	68.7 (37.8)	77.2

* Indicates re-application of spherix; Figures in paretheses shows per cent protection

TABLE 7: DELHI: ENTRIES OF MOSQUITOES PER STRUCTURE/NIGHT IN VILLAGE DEHRA (EXPT.) AND DHAULANA (CONTROL) IN PHC DHAULANA, DISTRICT GHAZIABAD, U.P.

Month	An. culicifacies		Total Anophelines		Culex		Total mosquitoes	
	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Aug '93	110.0	4.0	367.0	298.0	5.0	156.0	372.0	454.0
Sept	7.8	10.8	63.8	126.5	22.3	41.8	86.1	168.3
Oct	61.0	18.0	136.0	106.0	114.0	212.0	250.0	318.0
Nov	53.0	13.0	131.0	81.0	114.0	206.0	245.0	287.0
Dec	39.0	13.0	80.0	35.0	116.0	290.0	196.0	325.0

throughout the study. Average post application density in control village was ranging from 39.8 to 110 per dip as against 0 - 2.3 per dip in experimental village during the corresponding period.

Similarly, adult density of Culex spp. was comparable during pre-spray period in both experimental and control village but application of spherix @ 1 gm/sq m gradually reduced MHD of Culex spp. in successive weeks of treatment. The initial reduction was 66.2% in the month of May which increased to 91.0% in June 1993. The same level of reduction with marginal fluctuations was maintained throughout the study. However, man hour density of control village remained high upto May than sharply declined in the month of June and maintained at more or less at the same level with seasonal fluctuation.

Table 6 depicts the monthwise data of average density of anopheline from different habitats in experimental and control villages. It appears from the Table that larvicidal activity of Spherix wettable formulation @ 1 gm/m was not as remarkable on anopheline as observed against culicine immatures. Initial per cent reduction was ranging from 34.7 to 53.6% in following month of May and June but gradually enhanced from July onwards and ranged from 70.8 to 90.3%. The average pooled anopheline density in control village during post-application period was ranging from 3.5 to 7.4 per dip as against 0.19 to 2.02 per dip in experimental village.

It may be noted that immature reduction was not reflected in either adult densities of anopheline or An. culicifacies in experimental village. The post-application average reduction in man hour density of anopheline was ranging from 7.5 to 51.5 as against 2.3 to 50.8% with An. culicifacies. In fact density of An. culicifacies was found higher in comparison to control in August, September, November and December 1993.

Impact of spraying on man mosquito contact: Monthwise results of entry of mosquitoes in experimental and control village encountered from dusk to dawn during post-application of biolarvicide are given in Table 7 and landing rate in Table 8. It appears from the Table 7 that there was considerable reduction of Culex mosquito in experimental village during August and September which was diluted in subsequent months. However, the impact of biolarvicide on entry of anopheline and particularly An. culicifacies was not evident in most of the observation months. The marginal impact was seen only when entry of total mosquitoes in experimental and control village was compared. Similar observations were made when landing rate of mosquitoes on indoor human bait of experimental and control village was compared.

TABLE 8: DELHI: LANDING OF MOSQUITOES ON HUMAN BAIT/NIGHT/BAIT IN VILLAGE DEHRA (EXPT.) AND DHAULANA (CONT.) IN PHC DHAULANA, GHAZIABAD (U.P.)

Month	An. culicifacies		Total Anophelines		Culex		Total mosquitoes	
	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Jun '93	0.75	0.12	1.12	0.5	3.8	51.2	5.0	51.7
Jul	2.0	0.0	4.0	0.0	16.0	65.0	20.0	65.0
Aug	5.0	4.5	6.6	14.5	2.6	39.5	9.3	58.5
Sept	4.5	4.0	11.5	15.5	23.5	41.5	35.0	57.0
Oct	2.0	3.0	4.0	11.0	23.0	45.0	27.0	56.0
Nov	4.0	1.2	4.7	2.3	10.0	18.5	14.7	20.8
Dec	-	-	-	-	-	-	-	-

TABLE 9: DELHI: EPIDEMIOLOGICAL DATA OF VILLAGE DEHRA (EXPT.) AND DHAULAND (CONT.), PHC DHAULANA, DISTRICT GHAZIABAD, U.P.

Month	BER		SPR		SfR		Cases/000		Pf/000	
	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Feb '93	0.16	0.83	0.0	2.59	0.0	0.0	0.00	0.21	0.00	0.00
Mar	0.14	1.42	10.0	1.52	0.0	0.0	0.14	0.21	0.00	0.00
Apr	0.22	1.24	0.0	0.87	0.0	0.0	0.00	0.10	0.00	0.00
May	0.13	1.35	0.0	2.41	0.0	0.0	0.00	0.32	0.00	0.00
Jun	0.17	1.15	0.0	3.77	0.0	0.0	0.00	0.43	0.00	0.00
Jul	0.45	2.05	0.0	1.59	0.0	0.0	0.00	0.32	0.00	0.00
Aug	0.58	0.07	15.0	28.5	0.0	0.0	0.88	0.21	0.00	0.00
Sept	0.88	0.15	11.6	28.5	3.3	14.2	1.0	0.43	0.29	0.21
Oct	0.60	0.18	31.7	5.8	21.9	5.8	1.9	0.10	1.3	0.10
Nov	0.89	0.19	39.3	11.11	36.3	5.5	3.53	0.21	3.23	0.10
Dec	0.23	0.22	12.5	4.76	12.5	0.0	0.29	0.10	0.29	0.00
Jan. 94	0.2	0.09	5.0	0.0	5.0	0.0	0.14	0.0	0.14	0.00
TOTAL	4.7	9.0	16.5	3.0	11.0	0.48	7.9	2.7	5.3	0.43

Impact of biolarvicide application on incidence of malaria

Monthwise epidemiological data of experimental and control village is given in Table 9. Pre-application data (February, March) of blood examination rate (BER) slide positivity rate (SPR), slide falciparum rate (SfR), cases/000 and Pf/000 population were more or less comparable. The post-application epidemiological data revealed month to month fluctuations in both experimental and control villages. However, the pooled data of each epidemiological parameter revealed that biocide application failed to interrupt transmission in experimental village.

Impact of biolarvicide in Mahipalpur NCT of Delhi

Mahipalpur is located in circle no. 178, Najafgarh zone of Municipal Corporation of Delhi near Vasant Kunj. It consists of about 1500 population of about 1500 distributed in 250 huts erected on Aravali hills. The main occupation of the inhabitant is mining and have migrated from Rajasthan states. Both An. culicifacies and An. stephensi are prevalent but An. stephensi is playing major role in transmission of malaria. Geographical reconnaissance (GR) revealed 50 pools, 2 ponds, 1 well, 1 drain and about 140 stone quarries. All these habitats were sprayed with Spherix wettable formulation @ 1 gm/sq m.

Control locality Lalkhet is located about 4.5 kms away from the experimental site and consists of a population of about 1550. There are 7 pools, 1 pond, 1 lake and about 500 stone quarries. The density of An. stephensi and An. culicifacies were comparable with experimental sites. Pre-application incidence of malaria were also more or less same. No antilarval measures were carried out in this locality.

Entomological: The average density/dip of culicine immature was 167 and 161.1 in experimental and control village respectively. Biolarvicide application resulted 99.8% reduction in the month of April. The same level of reduction was maintained up to August, 1993 and after that it was marginally diluted in successive months (Table 10). This may be due to sharp decline in density of immatures in control village from August onward.

Similarly, adult Culex density of experimental and control village was comparable before the application of biolarvicides but drastic reduction in man hour density of Culex spp. was observed during post-application period. The MHD of Culex species ranged from 3.4 to 9 in experimental village as against 32 to 119 in control village.

TABLE 10: DELHI: LARVAL AND DENSITY OF CULICINES IN MAHIPALPUR (EXPT.) AND LALKHET (CONT.)

Month	Average density/dip		Man hour density	
	Experimental	Control	Experimental	Control
Pre-density	167.0	161.1	60.0	57.0
Apr '93	1.0 (99.8)	333.5	9.0 (87.0)	62.0
May	3.0 * (99.3)	353.0	4.2 (93.3)	55.8
Jun	0.75 * (99.8)	311.2	4.0 (88.5)	31.2
Jul	0.0 * (100.0)	310.0	4.0 (86.0)	25.7
Aug	2.7 * (98.0)	118.2	3.4 (97.2)	105.6
Sept	7.4 * (82.0)	36.9	6.2 (95.2)	114.5
Oct	12.4 * (59.6)	27.6	5.2 (96.1)	119.5
Nov	11.0 * (71.9)	35.2	4.4 (93.8)	63.6
Dec	3.3 * (71.8)	10.5	5.2 (96.0)	114.5
Jan '94	1.8 (84.6)	11.7	3.6 (89.8)	32.0

* Indicates re-application of spherix; Figures in parentheses shows per cent reduction

The impact of biolarvicide application on immature and adult anopheline is shown in Table 11. As observed in Dehra village, the larvicidal activity of biolarvicides was not as pronounced on anopheline as observed against culicine larvae. The per cent reduction varied from 21.0 to 74.7 during post application period. Inconsistent results were observed when man hour density of anopheline, An. culicifacies and An. stephensi of experimental and control villages were compared. Since the adult density of vector species in both the villages were very low, valid conclusion cannot be drawn at this stage.

Epidemiological: Monthwise results of epidemiological parameters are presented in Table 12. Results revealed that incidence of malaria during pre-application period were marginally higher in control village. Average pooled data of BER, SPR, SfR, cases/000 and Pf/000 were 14.4, 6.9, 1.3, 10.0 and 2.0 in experimental village as against 28.5, 19.2, 8.5, 54.8 and 24.5 in control village respectively. This indicate that there was either reduction in malaria transmitted by An. stephensi or it is due to

TABLE 11: DELHI: LARVAL AND ADULT DENSITY OF ANOPHELES IN MAHIPALPUR (EXPT.) AND LALKHET (CONT.)

Month	Average density/dip		Man hour density					
			Total Anopheline		An. culicifacies		An. stephensi	
	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Pre-density	16.0	19.5	15.0	10.0	9.0	5.0	3.0	5.0
April'93	17.5 *	4.7	7.0	10.0	4.0	6.0	25.0	3.0
	(55.4)		(58.0)		(66.7)		(-33.3)	
May	24.5 *	37.2	5.2	9.2	2.4	5.2	1.4	3.6
	(21.0)		(66.1)		(77.0)		(37.8)	
Jun	-	-	3.7	7.2	2.0	5.0	1.2	1.7
			(69.2)		(80.0)		(-12.9)	
Jul	13.0 *	27.2	7.2	16.0	2.0	7.2	0.7	4.5
	(42.7)		(73.0)		(86.2)		(75.2)	
Aug	14.1 *	37.8	26.8	67.2	2.0	10.6	0.4	3.0
	(55.3)		(76.1)		(90.6)		(78.7)	
Sept	4.0 *	12.5	17.5	86.2	2.7	8.7	0.2	5.2
	(61.6)		(87.9)		(84.5)		(93.9)	
Oct	4.0 *	12.4	23.2	99.7	0.7	4.5	0.5	8.0
	(61.3)		(86.1)		(92.3)		(90.0)	
Nov	5.5 *	15.8	17.6	73.4	2.2	2.8	2.2	6.6
	(58.3)		(85.7)		(60.8)		(46.7)	
Dec	3.0 *	9.2	19.5	86.2	1.5	8.7	0.0	5.2
	(60.9)		(86.5)		(91.4)		(100.0)	
Jan '94	2.0 *	9.5	4.2	9.2	1.2	2.0	0.2	1.2
	(74.7)		(72.6)		(70.0)		(73.3)	

* - Indicates re-application of spherix; Figures in parentheses shows per cent reduction

TABLE 12: DELHI: EPIDEMIOLOGICAL DATA OF VILLAGE MAHIPALPUR (EXPT.) AND LALKHET (CONTROL)

Month	BER		SPR		SfR		Cases/000		Pf/000	
	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.	Expt.	Cont.
Mar '93	0.6	0.7	10.0	25.0	0.0	0.0	0.7	1.9	0.0	0.0
Apr	1.6	1.4	8.3	39.1	0.0	0.0	1.3	5.8	0.0	0.0
May	1.6	1.5	16.0	25.0	0.0	8.3	2.7	3.9	0.0	1.3
Jun	1.6	2.1	8.3	30.3	4.1	6.1	1.3	6.4	0.66	1.3
Jul	3.2	2.9	0.0	6.7	0.0	0.0	0.0	1.9	0.0	0.0
Aug	2.0	3.4	6.7	15.1	0.0	5.7	1.3	5.1	0.0	1.9
Sept	1.4	3.3	9.5	19.2	0.0	3.8	1.3	6.4	0.0	1.3
Oct	1.2	6.6	0.0	20.3	0.0	15.5	0.0	13.5	0.0	10.3
Nov	0.6	2.3	22.2	19.4	22.2	16.6	1.3	4.5	1.3	3.8
Dec	0.4	2.3	0.0	21.6	0.0	18.9	0.0	5.3	0.0	4.6
Jan '94	0.06	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	14.4	28.5	6.9	19.2	1.3	8.5	10.0	54.8	2.0	24.5

low endemicity and BER in experimental area in comparison to control.

Results of field trial in both sites are still in progress and will be completed in March, 1995.

VII) MADRAS, TAMIL NADU

During 1993, Madras city recorded 76,575 cases of malaria, of which 5888 were P. falciparum. Though the city recorded a reduction in the incidence of P. falciparum by about 2000 cases (7858 cases recorded in 1992) there was an overall increase in total number of malaria cases by about 4300 cases (72314 reported cases in 1992). The stratification of the Corporation divisions based on API has revealed that 37 out of a total of 155 divisions exhibited an API of 20 and above, and 24 divisions fell under the category of 11-19 API. The number of high incidence divisions i.e., those exhibiting an API of 20 and above was almost the same as that of 1992.

The Integrated Disease Vector Control operations were continued in 3 Corporation divisions 79, 80 & 81 with a population of about 90,000. the number of overhead tanks (OHTs) and wells into which Gambusia fishes were introduced ranged from 713 - 932 and 423 - 535 respectively on a monthly basis. The per cent positivity in the three experimental divisions ranged from 6.55 to 11.8 and that of wells from 2.6 to 10.3 during the 12 month observation period.

Re-introduction of fishes was necessary in 12% OHTs and 9% wells on a monthly basis either because of paucity of food or removal during cleaning/drawing water. The breeding status, and per cent OHTs and wells requiring re-introduction on a monthly basis has been given in Table 1.

The adult An. stephensi density was monitored on a fortnightly basis in 6 catching stations (fixed); 2 each in the three experimental divisions. The per man hour density of An. stephensi (based on the number of cowshed resting mosquitoes collected between 1830 to 2030 hrs) ranged from 1.5 to 25.5. The MHD of An. stephensi recorded in the experimental and control areas is given in Table 2.

The Malaria clinic in the office premises and experimental area (Chintadripet) continued to function. The number of blood smears examined and the number found positive for the period January-December 1993 for both the clinics are given in Tables 3 and 4. In Chintadripet clinic, a total of 1654 blood smears were examined; of which 434 were found positive (381 - P. vivax and 52 - P. falciparum) with a SPR of 26.2%. Of these, 320 positive cases (73.7%) were recorded from slums located in divisions 79 and 36 cases from slums of other divisions. The contribution of slums to the total malaria cases recorded in all the experimental divisions was about 82% (Table 3). In the Anna Nagar clinic a total of 2292 blood smears were examined of which 676 were found positive for malaria parasites (633 - P. vivax and 43 - P. falciparum) with a SPR of 29.4% (Table 4).

TABLE 1: MADRAS: CONTROL OF AN. STEPHENSI BREEDING IN OVERHEAD TANKS AND WELLS BY USING GAMBUSIA FISHES DURING THE YEAR 1993

Habitat	Status	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Overhead tank	No. with water	726	824	783	722	713	751	927	858	922	932	843	885
	No. fish reintroduced	68	70	55	30	-	50	51	50	34	59	58	66
	% reintroduced	11.8	10.6	8.7	5.52	-	9.34	10.0	10.9	6.55	11.34	10.6	10.7
	% breeding in experimental area	1.37	1.22	0.69	0.84	1.17	1.0	1.6	1.5	1.7	2.36	1.5	2.5
Well	No. with water	490	535	499	444	423	437	523	481	538	522	483	535
	No. fish reintroduced	35	26	28	22	24	30	31	27	17	24	39	34
	% reintroduced	7.1	4.8	2.6	4.9	5.67	6.86	8.11	8.38	4.49	7.05	10.3	7.31
	% breeding in experimental area	-	-	-	-	-	-	0.2	0.2	0.18	0.19	0.41	0.3
Control Area													
Overhead tank	% breeding	38.46	-	20.9	29.4	20.6	29.09	25.6	26.27	24.36	26.4	20.7	25.0
Well	% breeding	2.56	-	17.24	21.4	-	4.16	1.12	5.43	-	3.5	1.1	-

TABLE 2: MADRAS: PER MAN HOUR DENSITY OF AN. STEPHENSI IN EXPERIMENTAL AND CONTROL AREAS BASED ON COWSHED RESTING COLLECTIONS

Month	Fort night	Experimental area		Control area
		Sowcarpet	Chintadripet	Zam Bazar
Jan	I	4.0	1.6	3.7
	II	10.6	4.8	2.2
Feb	I	12.9	2.0	2.4
	II	*	3.6	2.0
Mar	I	-	1.5	5.2
	II	-	2.0	4.0
Apr	I	-	3.0	8.0
	II	-	1.5	5.0
May	I	-	3.6	3.0
	II	-	2.5	12.0
Jun	I	-	4.5	5.4
	II	-	2.4	5.0
Jul	I	-	2.8	2.0
	II	-	4.4	10.5
Aug	I	-	5.7	2.5
	II	-	13.5	51.0
Sep	I	-	12.8	18.7
	II	-	4.0	-
Oct	I	-	20.2	24.0
	II	-	15.2	69.6
Nov	I	-	25.5	32.0
	II	-	18.0	16.0
Dec	I	-	6.0	3.4
	II	-	3.6	2.6

* Studies suspended after first fortnight observations in February

Biocide trials:

Two biolarvicide formulations spherix and Bactoculicide received from Russia are being field tested on a large-scale against Cx. quinquefasciatus in Coovum and Otteri nallah

TABLE 3: MADRAS: RESULTS OF BLOODSMEAR EXAMINATION IN THE MALARIA CLINIC OF CHINTADRIPET - EXPERIMENTAL AREAS

Month	Slums of Div. 79			Division 79			Divisions 80 & 81			Total		
	BSE	Pos.	Pf	BSE	Pos.	Pf	BSE	Pos.	Pf	BSE	Pos.	Pf
1993												
Jan	48	19	6	6	1	0	3	0	0	57	20	6
Feb	68	13	3	10	2	0	7	2	0	85	17	3
Mar	54	15	1	12	8	1	11	3	0	77	26	2
Apr	62	16	0	11	2	0	7	4	1	80	22	1
May	81	18	0	6	2	0	7	2	0	94	22	0
Jun	158	36	10	68	15	1	12	3	0	234	54	11
Jul	147	40	1	10	3	0	16	8	0	173	51	1
Aug	94	19	0	11	5	0	5	1	0	110	25	0
Sep	190	47	4	-	-	-	-	-	-	190	47	4
Oct	191	39	4	-	-	-	12	3	1	203	42	5
Nov	214	74	9	-	-	-	7	2	1	221	76	10
Dec	116	32	9	-	-	-	10	0	0	126	32	9
Total	1423	368	47	134	38	2	97	28	3	1654	434	52

* Also includes positive cases recorded from other divisions

TABLE 4: MADRAS: RESULTS OF BLOODSMEAR EXAMINATIONS IN MALARIA CLINICS AT ANNA NAGAR (1993)

Month	Anna Nagar			Mogappair			Others			Total		
	BSE	Pos.	Pf	BSE	Pos.	Pf	BSE	Pos.	Pf	BSE	Pos.	Pf
Jan	30	8	1	54	7	1	24	5	1	108	20	3
Feb	35	12	1	40	8	1	16	0	0	91	20	2
Mar	32	12	0	35	9	0	19	7	0	86	28	0
Apr	43	19	0	61	28	1	17	8	0	121	55	1
May	39	23	0	67	36	0	12	7	0	118	66	0
Jun	60	32	0	66	32	0	37	8	0	163	72	0
Jul	62	33	0	81	32	1	35	10	0	178	75	1
Aug	105	47	0	131	31	2	51	11	2	287	89	4
Sep	145	47	3	173	22	3	85	10	3	403	79	9
Oct	109	40	4	116	21	1	77	10	1	302	71	6
Nov	92	28	9	131	26	5	53	8	0	276	62	14
Dec	59	19	3	75	19	0	25	1	0	159	39	3
Total	811	320	21	1030	271	15	451	85	7	2292	676	43
SPR	39.45			26.3			18.8			29.4		

TABLE 5: MADRAS: DENSITIES OF III AND IV INSTAR CULICINE LARVAE AND THEIR PERCENTAGE REDUCTION IN TRIAL AREAS

Round No.	Coovum/Spherix Trial area		Otteri/Bactoculicide trial area		Railway Canal control area	Remarks
	No. of larvae per dip	% reduction	No. of larvae per dip	% reduction	No. of larvae per dip	
0	248		160		75	Pre-treatment
I	46	98.12	51	96.76	740	Post-treatment
II	87	84.15	45	87.29	166	
III	19	90.58	14	89.24	61	
IV	40	80.16	20	84.63	61	
V	14	97.66	13	96.63	181	
VI	7	96.07	16	86.11	54	
VII	18	95.71	5	98.15	127	
VIII	104	96.27	44	97.55	845	
IX	58	90.36	50	87.12	182	
X	31	93.15	25	91.44	137	
XI	52	79.03	35	78.12	75	
XII	65	83.75	19	96.12	121	
XIII	63	77.04	10	94.35	83	
XIV	32	78.96	14	84.75	46	
XV	32	78.49	35	63.54	45	
XVI	35	69.75	31	95.98	35	Low coverage due to lack of supervision
XVII	60		6		4	Rainy season
XVIII	48		2		2	Rainy season
XIX	39		5		1	Rainy season
XX	16	91.04	9	92.18	54	
XXI	34	90.74	45	81.60	111	
XXII	48	85.48	10	95.31	100	

respectively. Both the rivers carry sewage. A stretch of 8 km in Coovum river is under the treatment of Sphearix and 6 km stretch of Otteri nallah is treated with Bactoculicide. The spraying of biolarvicides extends to one meter from the border of the river. In addition, all potential breeding sources of Cx. quinquefasciatus, particularly the storm water drains located within 1 km on either side of the bank of these two rivers were sprayed with respective formulations. Railway canal has been retained as control/check area. The treatment is carried out once a fortnight. The spraying operation was organized in such a way that Coovum and Otteri nallah were treated on alternate weeks, the post-treatment observations were carried out in the following week after treatment.

Both larval and adult mosquito densities are measured for evaluating the efficacy of the formulation. The larval collections are being carried out in 40 to 80 sampling points in each zone which extends to about 600 to 1200 m length. Adult mosquito collections are undertaken in 8 fixed catching stations/zone (4 stations located near Coovum/Otteri and the other 4 away from the river). The immatures were transported to the laboratory and were counted instarwise. Both the formulations are applied @ 1.0 gm/sq m water surface. Both the larval and adult density monitoring were carried out on a fortnightly basis.

The spraying of Spherix commenced from 29 March 1993 and that of Bactoculicide from 6 April 1993. So far 22 rounds have been completed. The pre- and post-treatment observations on larval density commencing from round no. 1 alongwith the findings of check area are given in Table 5. The study has revealed that the per cent reduction in larval density in Coovum river ranged between 69.75 to 98.12. In Otteri nallah which was under the treatment of Bactoculicide the per cent reduction in larval density ranged from 63.54 to 98.15. The number of larvae/dip in Coovum river ranged from 7 to 104 and in Otteri nallah from 5 to 51 against a density of 35-845/dip encountered in the control area.

Larvivorous potential of Gambusia affinis:

Larvivorous potential of Gambusia affinis was studied in laboratory conditions against Cx. quinquefasciatus. The rate of consumption of larvae/day/fish was evaluated by releasing 30-60 II and IV instar larvae into the containers with 5 litre water. The rate of consumption was determined after 10, 20, 30, 60, 120 minutes of introduction and a total of 24h count was taken. The experiment was designed in such a way that a know number of larvae was added daily to each container having one fish. On day 1, 30 III and IV instar larvae were introduced, on day 2 and 3, 50 larvae were introduced and from day 4 to 10 the number of larvae introduced was 10. The average number of III and IV instar

Cx. quinquefasciatus larvae consumed by one fish/day ranged from 18.3 to 49.5 in 5 replicate studies with an overall average of 38.18 larvae/fish/day. The experiment was conducted in well water with a pH of 7.6, salinity - 0.4/00, total hardness (as Calcium Carbonate - 510mg/l) and turbidity - 2 ppm. The total length of fishes (cm) and weight (gm) were taken before and after the termination of the experiment (10 days after). The average increase in weight ranged between 0.28 to 0.55 gm and average increase in length ranged from 0.1 to 0.3 cm in replicate trials.

Biology of An. stephensi:

Studies on the biology of An. stephensi were continued with emphasis on cytotaxonomy. Taking Sowcarpet area (Corporation divisions 30,48 and 49) which is a typical urban locality as well as an area which has been reporting high incidence of malaria in the city as a central point, 18 sites were selected in and around the city in different directions towards the periphery. Larval collections were made in OHTs and wells from all the 18 sites. The larvae were reared and ovaries were taken out from semi-gravid adults for inversion polymorphism in poletene chromosomes. The egg ridge number were counted to identify the variety/ies encountered in each area. The study covered following sites:

1. South : Chintadripet, T. Nagar, Mylapore, Perungalattur, Madipakkam, Kovalam and Mamallapuram.
2. East : Anna Nagar, Avadi, Tiruvarkadu and Poonamalle.
3. North : Manali, Kodungaiyur, Vyasarapadi and Madhavaram.
4. N.East: Red Hills and Villivakkam.

An. stephensi larvae could be collected from all the sites. In addition to the above places, An. stephensi larvae were collected from Salem, Erode and Tuticorin town having urban malaria problem; Baragur village near Hosur in Dharmapuri district, Bangalore and Cochin cities.

The study has revealed that An. stephensi population could be grouped into 3 ecological variants based on egg ridge numbers. In 6 areas of Madras city only type forms were encountered, intermediate forms in 12 sites and mysorensis forms in 3 areas; there was overlapping in 3 sites which had both type and intermediate forms. Salem, Erode, Baragur and Bangalore revealed the presence of only intermediate forms. But, Cochin population was found to comprise both intermediate and mysorensis forms. The population of An. stephensi in all the three areas surveyed was found to be polymorphic for 'b' inversion on arm 2 except Manali and Red Hills. So far, 5 types of inversions have been recorded.

Seasonal changes in survival of immatures were also studied using floating cages in open overhead tanks. Complete horizontal lifetable was also determined for both laboratory stock and intermediate form.

An. stephensi was, for the first time in Madras city incriminated positive for sporozoites by dissection. One out of 2699 adult mosquitoes dissected was found positive for sporozoites during December 1992 and one was found positive for oocyst (November 1993). The mosquitoes were collected from Chintadripet. Blood meal analysis was carried out using gel diffusion techniques. Out of 428 bloodmeal samples examined 316 (74%) gave bovine positive, 1 showed mixed blood reaction and the rest did not react. It may be added that the adult An. stephensi collected were from cowsheds. Attempts made to collect adult specimens of this species from human dwellings were not successful.

Ricefield studies:

Studies were undertaken in ricefields located near Red Hills covering one rice planting season; (Samba crop June to October). The immatures were sampled using a quadrat made of galvanized iron measuring 0.1 sq m in five selected ricefield plots. Ten samples were taken from each ricefield plot. The immatures sampling was carried out from the time fields were flooded until availability of standing water in fields at weekly intervals. The immatures were transported to the laboratory, anophelines and culicines separated, counted, reared and identified after emergence of adults. The ricefields were found to support breeding of ten species of mosquitoes; 4 anophelines (An. barbirostris, An. nigerrimus, An. subpictus and An. vagus and 6 culicines (Cx. bitaeniorhynchus, Cx. (Lutzia) fuscanus, Cx. fuscocephala, Cx. pseudovishnui, Cx. tritaeniorhyn-chus and Cx. vishnui).

The immature density of anophelines started building up from the time fields/fallow fields were flooded and peaked one week after transplantation with 3850 immatures/sq mt. Thereafter, the density declined sharply and was found to range between 15 and 90 sq m from 4th to 10th week after transplantation. In case of culicines, the density was lower during the initial stages of rice cultivation (i.e., flooding and transplantation) but gradually reached a peak during the 5th week after planting with 1897 immatures/sq m. Following this, there was a decline in the immature density with minor fluctuations. Both anophelines as well as culicines were found to breed in ricefields upto 10 weeks following transplantation. Mosquito breeding ceased thereafter as the fields were kept dry prior to harvest.

Among anophelines, An. subpictus was the only species encountered from the time the fallow fields were flooded up to 4 weeks after transplantation. During the V week An. vagus appeared and during VI week after transplantation this species predominated. It was interesting that An. subpictus was replaced by An. nigerrimus from VII week onwards. An. barbirostris was encountered in flooded fields only.

Among culicines, Cx. tritaeniorhynchus was the first to appear as soon as the fallow fields were flooded. This was the only culicine species to be encountered till 2 weeks after tranplantation. Cx. pseudovishnui and Cx. vishnui were found breeding during the IV week. While the breeding of Cx. vishnui extended to V week, the breeding of Cx. pseudovishnui disappeared after III week. Cx. tritaeniorhynchus was the sole culicine mosquito to breed in rice fields among the culicines between VI and X week after transplantation.

P. vivax relapse pattern:

This study was undertaken in Chintadripet area. All P. vivax positive cases with 2% parasitaemia registered at the malaria clinic were followed up for a period of 12 months. During the follow-up blood smears were collected once a month irrrespective of the fact whether the case had fever or not. Out of a total of 362 P. vivax cases registered at the clinic, 105 cases were selected. Of these follow-up studies could be completed in only 95 cases. Out of these 95 cases, 49 came down with relapse. The interval between the first and subsequent attacks indicated that in 12 cases malaria relapsed in 4 weeks after the initial attack, in 17 cases in 8 weeks, in 7 cases after 12 weeks, in 8 cases after 16 weeks and in 2 cases each after 20 and 24 weeks. In one case the infection relapsed after 36 weeks. Analysis of the data on the number of times an individual was found positive in an year revealed that 14 cases had once, 8 cases twice, 4 cases thrice and 2 cases 4 times relapses.

Chloroquine resistance in P. falciparum:

The study was undertaken jointly by the MRC and the Health Department, Corporation of Madras in Sowcarpet area from November 1993. The screening of 9 fever cases and laboratory work were carried out at the Central Malaria Laboratory, Corporation of Madras. All P. falciparum cases were administered 1500 mg chloroquine. Follow-up blood smears from all falciparum cases were collected on day 3, 7, 14 and 28 after detection and administration of drugs. A total of 236 P. falciparum cases were selected for the study. But, only 78 cases could be followed-up

completely. The study revealed that 36 out of 78 cases were sensitive and 42 were resistant at R1 level.

Socio-economic status of malaria positive cases:

The socio-economic status of malaria positive cases attending the clinic in Sowcarpet was determined using a questionnaire which provided data on five parameters such as monthly income, occupation, type of dwelling, family status and anti-mosquito measures practiced. It revealed that as many as 92.3% of the cases attending the clinic were in an income range of less than Rs. 2000/- per month. Of these, 60% were in an income range of less than Rs. 1000/- per month, labourers accounted for about 72%. In regards to type of dwelling, 30% were residing in messes (eating houses) and about 18% spent nights in groups in shops/godowns where they work. Persons having self-treatment and consultation with private medical practitioners accounted for 63.8% of the total positive cases attending the clinic. This was evident by the fact that 33.8% gave the history of having taken drugs themselves before registering at the clinic. 30 per cent of the patients gave the history of having consulted a private medical practitioner before coming to the clinic.

Health Education/Workshop

The health education activity was continued during the year under report. Health education/awareness programmes were organized in collaboration with voluntary organizations. During the period ten education camps were organized of which 7 were lecture-cum-demonstrations, 2 were medical camps and one intersectoral meeting. A total of 4145 people participated in these activities.

In addition, the field station also organized one day lecture/demonstration classes for the students of Diploma in Medical Laboratory Technology on malaria and its control with special emphasis on blood smear collection, staining and identification of malaria parasites. The students were from Layolla college and Microclinical Laboratory and Education Centre, Madras. In addition a demonstration was organized for 51, 2nd year MBBS students of K.M.C. Medical College.

A workshop to the Assistant Health Officers, Senior Entomologists, Entomological Assistants and Sanitary Inspectors of the Health Department, Corporation of Madras was organized on 18 August 1993, on Biolarvicides, their application and evaluation. This was in connection with the treatment of Spherix and Bactoculicide in Madras City.

M/s Usha Group, New Delhi, arranged a lecture followed by a demonstration on Geographical Information System at the premises of the field station on 18 November 1993. This was attended by the scientific staff of the field station, members of the Directorate of Public Health and Health Department, Corporation of Madras (Tables 6 and 7).

TABLE 6: MADRAS: HEALTH EDUCATION ACTIVITY OF THE MRC FIELD STATION, DURING 1993

Organization	Month	No. participated	Purpose
Ambattur Industrial Estate Management Assn.	Jan	1000	Exhibition & medical camp
Green Valley Matriculation School, Mogappair	Jan	17	Health education & demonstration
Civic Exnora I			
a) Mylapore	Feb	2000	Health education at R.R. Sabha
b) Chintadripet	Apr	150	Health education
N. Colony (Chintadripet)	Mar	150	Health education & demonstration
S.B.I. Chintadripet (staff)	Mar	18	Health education & demonstration
Madras Christian Council of Social Service, S.M. Nagar Chintadripet	Aug	300	Health awareness campaign
YASS, MGR colony, Anna Nagar	Sep	400	Medical camp
MRC/MCM intersectoral co-ordination meeting with invited citizens	Aug	40	Intersectoral meeting in connection with mosquito/ malaria control
National College of Education for Women, Triplicane - NSS camp held at Avadi	Nov	70	Lecture cum demonstration

TABLE 7: MADRAS: TRAINING/WORKSHOP ORGANIZED BY THE MRC FIELD STATION DURING 1993

A. Training		
Diploma in Medical Laboratory Technology (P.G. Diploma students)		
i) Loyalla College?	August	26 students
ii) Microclinical Laboratory and Education Centre	July	140 students
iii) K.M.C. Medical College, Madras (Students) II Yr.	June	51 students
B. Workshop/demonstration programme by M/s. Usha Group, New Delhi to Medical Officers/Entomologists of MRC/Directorate of Public Health and Municipal Corporation of Madras Lecture cum demonstration on GIS.	November	40 members
C. Biocide workshop organized by the MRC, Madras to the members of the Health Department, Corporation of Madras which included Assistant Health Officers, Senior Entomologists, Entomological Assistants and Sanitary Inspectors (In connection with the treatment and evaluation of biocide formulation used)	August	40 members
D. Workshop for engineers and Public Health personnel - organized by the Air-Force Station, Tambaram, Madras. (Active participation in the workshop)	December	

Mosquito breeding in sewage treatment farms

The city of Madras has five sewage treatment plants with farms. The sewage water, after the treatment is used for grass cultivation. All sewage treatment farms are sources for culicine mosquito breeding because of water logging. A survey carried out

in these farms revealed extensive mosquito breeding. The breeding of the Cx. quinquefasciatus, Cx. tritaeniorhynchus and Cx. gelidus was encountered. While Cx. quinquefasciatus was found breeding in all the five farms, the breeding of Cx. tritaeniorhynchus was encountered in Kodangayur farm located on the northern outskirts of the city and the breeding of Cx. gelidus was found confined to Villivakkam farm. However, in one of the farms which had clear water in trenches, breeding of An. subpictus was found. The BOD level in Kodangayur farm was 345 mg/l as against 60 mg/l which is considered as normal permissible limit. The Chemical Oxygen Demand was 2300 mg/l as against a normal permissible level of 250 mg/l. It is interesting to note that Cx. tritaeniorhynchus was found breeding in polluted waters with BOD as high as 345 mg/l.

(VIII) MANDLA, MADHYA PRADESH

During 1992, as a result of successful demonstration of bioenvironmental control of malaria in Bizadandi PHC of District Mandla, in January 1993, the PHC was handed over to the State Government (N.M.E.P.) for the control of Malaria. The entire PHC was sprayed with 2 g/m^2 DDT in May and July. But the malaria situation in PHC deteriorated and focal outbreak recorded in many villages. The average annual parasite incidence (API) in 1993 touched the mark of 213 from an average of 152 in 1992 (Table 1). Similarly, slide positivity rate and slide falciparum rates were also very high in 1993 in comparison to preceding year 1992. Progress of field research for the period under review is briefly described below.

Entomological Studies

Repellent action of Neem oil: In an effort to develop an effective, indigenous and cheap method of protection from mosquito bites, trials on the repellent action of Neem oil on mosquitoes were carried out.

Neem oil was mixed in Coconut oil (Sharma et al, 1993) to make 1, 2, 3 and 4% concentration. Five ml of each concentration was applied to the exposed body parts of a volunteer before 1800 h and simultaneously plain Coconut oil was applied to another volunteer for control. Collections were made from 1800 h to 0600 h for 30 nights between March to September when the anopheline densities were highest.

Table 2 shows that Neem oil provides 60, 72, 78 and 89% protection at 1, 2, 3 and 4% respectively against An. culicifacies during a period of 12 hours. Results revealed (Table 3) that significantly more unfed An. culicifacies were caught on volunteers with Neem oil (26%) than Coconut oil (6%). It was also observed that more anophelines (63%) were caught after midnight on the volunteers having Neem oil application (Table 4) as compared to control group (48 %).

Malaria control has become highly problematical in tribal areas due to high densities of vectors, resistance to insecticides, exophilic and exophagic vector behaviour, operational failures and financial constraints. In this context, the repellent action of Neem oil in providing protection against bites of Anopheles culicifacies can be of great help in malaria control.

Use of light trap in ecological studies: Use of light trap was undertaken for sampling malaria vectors in ecologically different terrain. The objectives were to determine the species

of adult mosquitoes, their seasonal prevalence, endophilic and exophilic preferences in relation to malaria transmission.

A total of 4 villages were selected, 2 road side deforested villages (<500 m elevation) and 2 interior forested villages (<600 m elevation). Both deforested villages were

TABLE 1: MANDLA: COMPARATIVE EPIDEMIOLOGICAL SITUATION OF INDICATOR VILLAGES OF BIZADANDI PHC DURING AND AFTER BIOENVIRONMENTAL CONTROL PROGRAMME (1992-1993)

Villages (pop.)	Year	BSE	+ve	Pv	Pf	SPR	SfR	Pf %	API	ABER
Tarwani	1992	303	81	37	44	26.73	14.52	54.32	171.25	64.06
(473)	1993	333	102	38	64	30.63	19.21	62.74	215.60	70.40
Ramtila	1992	359	83	43	38	23.12	10.58	45.78	96.94	41.84
(858)	1993	252	62	21	41	24.60	16.26	66.12	72.26	29.37
Magardha	1992	216	56	22	32	25.93	14.81	57.14	61.34	23.66
(913)	1993	279	110	18	92	39.42	32.97	83.63	120.48	30.55
Kalpi	1992	423	108	61	45	25.53	10.64	41.67	91.91	36.00
(1175)	1993	468	156	68	86	33.33	18.37	55.12	132.76	39.82
Bhabhera	1992	347	90	24	66	25.94	19.02	73.33	142.63	54.99
(631)	1993	271	122	25	95	45.01	35.05	77.86	193.34	42.94
Jamunpani	1992	78	13	7	6	16.67	7.69	46.50	87.84	52.70
(148)	1993	85	26	6	20	30.58	23.52	76.92	175.60	57.43
Chargaon(K)	1992	433	124	45	76	28.64	17.55	61.29	167.34	58.43
(741)	1993	219	63	20	43	28.76	19.63	68.25	287.67	29.55
Bilnagri	1992	477	104	51	53	21.80	11.11	50.96	201.16	92.26
(517)	1993	261	108	22	85	41.37	32.56	78.70	208.89	50.48
Chargaon(M)	1992	566	190	120	70	33.57	12.37	36.84	240.81	71.75
(789)	1993	641	340	106	230	53.04	35.88	67.64	430.90	81.24
Banjertola	1992	282	66	35	31	23.40	10.99	46.97	179.34	76.63
(368)	1993	183	83	16	66	45.35	36.06	79.50	223.54	49.72
Dungaria	1992	461	132	70	61	28.63	13.23	46.21	202.76	70.81
(651)	1993	529	254	93	160	48.01	30.24	62.99	390.16	81.26
Dudhuwa	1992	427	97	52	44	22.72	10.30	45.36	170.18	74.91
(570)	1993	500	188	75	113	37.60	22.60	60.10	329.80	87.72
Khapa	1992	196	58	20	38	29.59	19.38	65.32	173.13	58.51
(335)	1993	296	135	29	106	45.60	35.81	78.51	402.90	88.37
Katangi(K)	1992	469	137	95	40	29.21	8.53	29.20	212.07	72.60
(646)	1993	330	133	58	74	40.30	22.42	55.63	205.88	50.08
Birampur	1992	274	58	27	31	21.17	11.31	53.45	119.83	56.61
(484)	1993	231	76	40	35	32.90	15.15	46.05	157.02	47.72
Total	1992	5311	1397	709	675	26.30	12.71	48.32	151.86	57.73
(9199)	1993	4878	1958	635	1210	40.14	24.81	61.80	212.85	53.03

Figure in parentheses indicate population of villages; Study villages were handed over to State Government for malaria control; 13 mixed infection of P.vivax and P.falciparum in both the years

TABLE 2: MANDLA: RESULTS OF NEEM OIL AS A REPELLENT TO ANOPHELINES DURING ALL NIGHT COLLECTIONS (MARCH TO SEPTEMBER) IN BIZADANDI PHC

Neem oil (%) in Coconut oil	Number of anophelines landed on human volunteers in 30 nights					
	An.culicifacies			Anophelines		
	Neem oil	Control (Coconut oil)	% protection	Neem oil	Control (Coconut oil)	% protection
1	10	25	60.0	11	27	59.2
2	7	25	72.0	7	26	73.0
3	14	66	78.8	15	79	81.0
4	5	46	89.1	5	55	90.9

TABLE 3: MANDLA: ABDOMINAL CONDITION OF ANOPHELINES CAUGHT ON HUMAN VOLUNTEERS DURING ALL NIGHT COLLECTIONS (MARCH TO SEPTEMBER, 1993)

Neem oil (%) mixed in Coconut oil		Total anophelines caught	Abdominal conditions		
			UF	F	G
1%	NO	11	3	7	1
	CO	27	0	27	0
2%	NO	7	1	5	1
	CO	26	0	21	5
3%	NO	15	6	8	1
	CO	79	7	60	12
4%	NO	5	0	2	3
	CO	55	5	38	12
Total	NO	38	10	22	6
	CO	187	12	146	29

* NO = Neem oil; CO = Control (Coconut oil); ** UF = Unfed, F = Fed, G = Gravid

thickly populated (60% Gond), on the state highway about 1-5 km from Primary Health Centre and relatively prosperous. The forested villages were sparsely populated, 15-25 km from the main road and inaccessible for atleast 4 months in a year. These villages are controlled by forest department. People are illiterate, primitive and work mainly in forest nurseries. All the 4 villages were sprayed with DDT 2 g/m^2 by NMEP.

Mosquitoes were collected once in a month at each village using CDC light trap. The trap collection was done for

TABLE 4: MANDLA: REPELLENT ACTION OF NEEM OIL DURING ALL NIGHT COLLECTION IN VILLAGES OF BIZADANDI PHC (MARCH TO SEPTEMBER, 1993)

Neem oil concentration (%)	Type of oil applied on exposed body parts of volunteers	Number of mosquitoes caught on human volunteers	
		Before midnight (1800-2400h)	After midnight (2400-0600h)
1	NO	3	8
	CO	13	14
2	NO	2	5
	CO	16	10
3	NO	7	8
	CO	41	38
4	NO	2	3
	CO	27	28

* NO Neem oil; CO Control (Coconut oil)

TABLE 5: MANDLA: SPECIESWISE ANOPHELINE COLLECTED ON ANIMAL/HUMAN BAIT AND BY LIGHT TRAP DURING WHOLE NIGHT COLLECTIONS IN DEFORESTED AND FORESTED VILLAGES OF MANDLA (1992-1993)

Species *	Deforested villages						Forested villages					
	Light trap		AB		HB		Light trap		AB		HB	
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
An.culicifacies	285	133	552	331	22	23	60	117	193	110	15	11
An.fluviatilis	8	7	4	5	0	0	13	6	12	9	1	1
An.annularis	10	18	40	17	1	0	13	28	22	6	0	1
An.subpictus	27	23	41	31	1	0	6	11	54	18	1	1
An.theobaldi	6	6	81	37	0	1	38	47	75	32	0	0
An.splendidus	4	6	35	13	0	0	2	2	7	3	0	0
An.jeyporiensis	0	0	1	2	0	0	10	0	8	5	0	0
Total	340	193	754	428	24	24	142	210	371	183	17	14

AB - Animal bait; HB - Human bait; In - Indoor; Out - Outdoor; * Other species were found in small numbers

48 nights in a year (12 nights in each village from 1800-0600). Indoor resting and bait (animal/human) collections were also carried out simultaneously.

Performance of light trap in ecologically different villages: Table 5 summarizes the number of anophelines caught at each location by light trap as well as by bait. During the study 545 anopheline representing 11 species were collected by light trap from deforested villages of which 418 (76.6%) were An. culicifacies followed by An. subpictus (9.2%). Only 15 An. fluviatilis were caught (2.8%) mainly during post-monsoon season. A total of 363 anopheline representing 9 species were collected from forested villages. An.culicifacies was the predominant species forming 48.7% of total anopheline catches followed by An.theobaldi (23.4%). An.fluviatilis was more than 5% of total anopheline catch and prevalent during monsoon and post-monsoon period.

Actual breakup showed that highest density of An.culicifacies was obtained indoor in deforested villages while highest number of An.culicifacies were recorded outdoor from forested villages. The maximum catches of An.culicifacies per trap/ night was 70 (indoor) and 55 (outdoor) in deforested villages, while the maximum catches of An.culicifacies per trap collection was 32 and 91 respectively in forested villages. Thus the optimum location of a light trap for the sampling of anopheline is inside the house in forest cleared roadside village and outside the house in dense forest village.

Highest number of An.fluviatilis were recorded in forested villages. A comparison between the means of the anopheline catches in and outside collection in both the group of villages showed statistically significant difference ($p=<0.01$). Also the difference between the mean catch of An.culicifacies inside and outside was statistically significant ($p=<0.01$) in the two group of villages.

The outdoor abundance of An.culicifacies and An.fluviatilis was of significance from malaria control point of view, because these vectors may avoid contact with insecticide sprayed surfaces inside the house.

Animal bait collections from the two group of villages showed similar pattern except that second dominant species in deforested villages was An.theobaldi as in forested villages. Human bait collections revealed that all the species were highly zoophilic.

Effect of moon phase: It was observed (Fig. 1) that significantly more anopheline were caught in dark (200 per trap/night) than in moon lit phase (136 per trap/night, $p=<0.05$). On animal bait also (Fig 2) more anophelines were collected during dark phase (16.7 per bait per night) than in moon phase (13.9 per bait/night; $p=<0.01$).

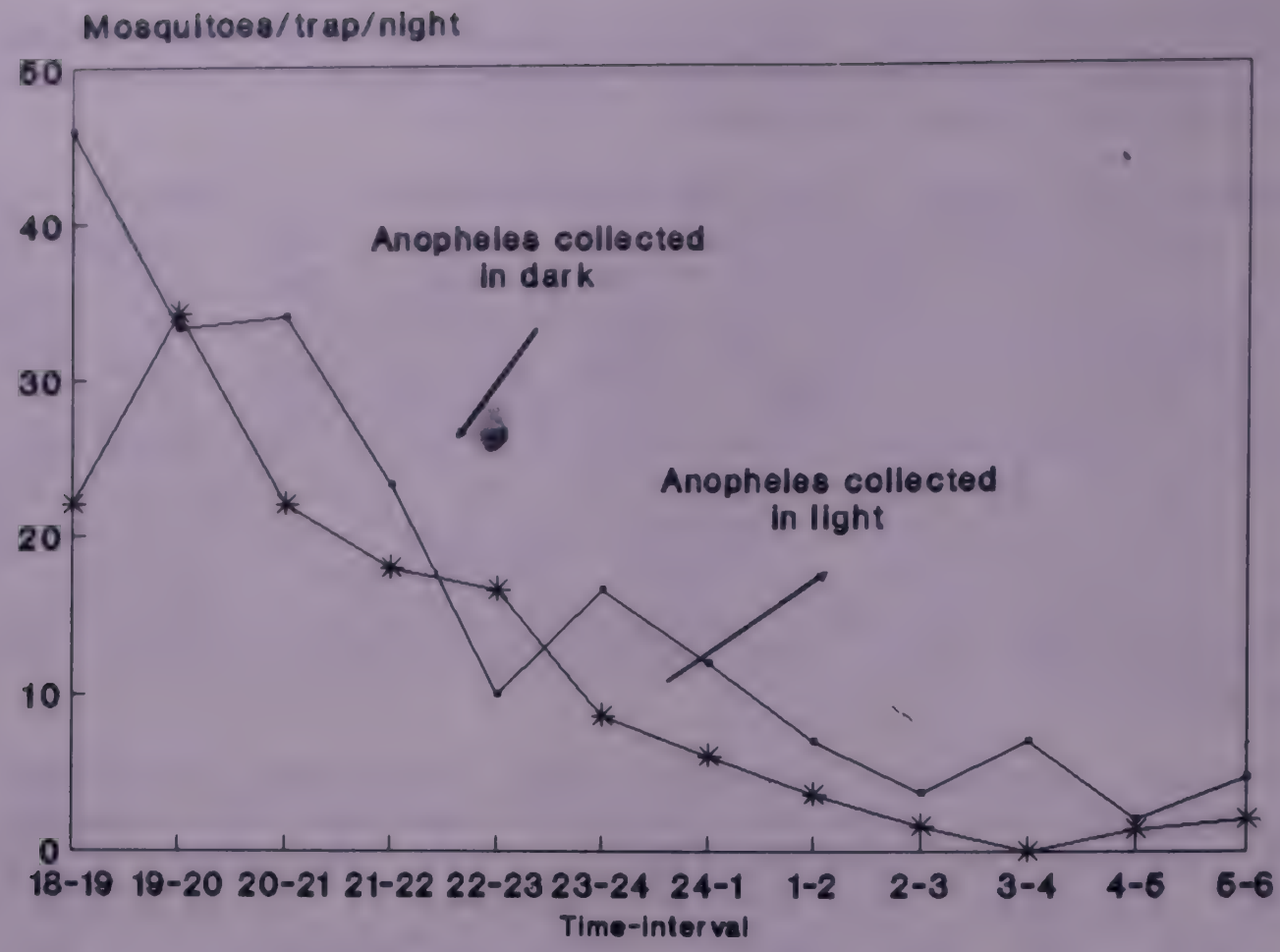


Fig. 1: Mandla: Effect of moon light on anopheline during light trap collections

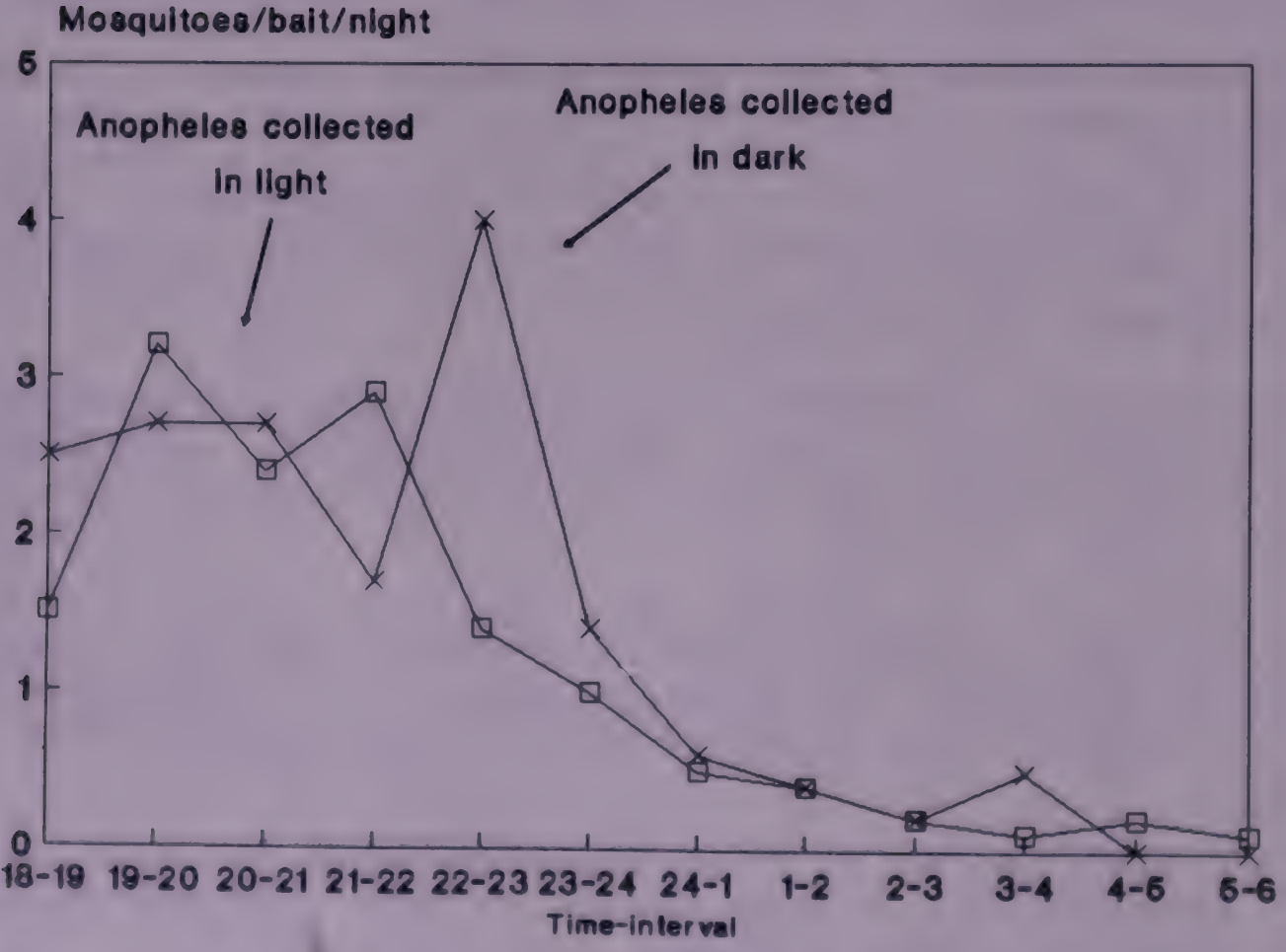


Fig. 2: Mandla: Effect of moon light on host seeking anophelines (animal bait)

Parity Status: In total 428 host seeking An.culicifacies were dissected from deforested villages and 114 from forested villages to determine oviparity (Table 6). The number of females dissected varied in time and space relative to abundance. The parity rate of An.culicifacies did not differ significantly in two groups of villages during summer and monsoon but during winter significantly less parous An.culicifacies females were recorded in forested villages ($p=<0.01$). This could be because of reduced sample size or perhaps due to reduced biting activity during winter.

The parous rates of An.culicifacies during full moon (50 %; n=38) and no moon (37.5%; n=24) were not significantly different.

Sex composition: In forested villages, fairly high percentage of male anopheline (14% in indoor and 12% in outdoor) were caught, whereas in deforested villages males were 11% and 7.5 % inside and outside respectively.

Anophelines in both the group of villages are most active at dusk and its peak activity appears between 1800-2100h and very few An.fluviatilis were attracted after 2200h (Table 7). Between 0100 to 0400h, the number of An.culicifacies caught were lowest in both the group of villages. Similar trends were observed in animal bait collections. The investigation showed that light traps could be used for sampling both endophilic and exophilic anophelines.

Vector incrimination: Indoor resting anophelines were collected fortnightly with suction tubes from two forested foothill villages during monsoon and post-monsoon seasons for vector incrimination. In these villages malaria prevalence was very high throughout the year with preponderance of P.falciparum (Table 8). These villages are about 10 km from the main road and surrounded by scrub jungle. They are intersected by a perennial

TABLE 6: MANDLA: SEASONWISE PARITY STATUS OF AN. CULICIFACIES IN FORESTED-CLEARED AND FOREST-VILLAGES OF DISTRICT MANDLA (M.P.)

	Deforested villages			Forested villages		
	No. dissected	No. parous	Parous %	No. dissected	No. parous	Parous %
Summer	62	38	61.29	8	4	50.00
Monsoon	258	116	44.96	73	35	47.94
Autumn	83	54	65.06	16	3	18.75

* Parity status of An. culicifacies caught on human bait in deforested villages (n=25: 64%); Forested villages (n=17: 82%)

TABLE 7: MANDLA: NUMBER OF AN. CULICIFACIES COLLECTED BY LIGHT TRAP IN FOREST-CLEARED AND FOREST-VILLAGES OF DISTRICT MANDLA (1992-1993)

Time interval	Outdoor		Indoor	
	Deforested villages	Forested villages	Deforested villages	Forested villages
1800-1900	19	9	52	9
1900-2000	33	19	68	6
2000-2100	19	18	29	3
2100-2200	12	9	33	5
2200-2300	8	6	19	5
2300-2400	3	13	10	1
2400-0100	9	11	5	0
0100-0200	1	4	0	3
0200-0300	0	1	3	4
0300-0400	0	0	2	3
0400-0500	1	13	9	4
0500-0600	7	10	8	1
Total	112	113	238	44

TABLE 8: MANDLA: MONTHWISE MALARIA SITUATION IN FOOT HILLS VILLAGES OF BIZADANDI PHC OF DISTRICT MANDLA

Months 1993	BSE	Total +ve	Pv	Pf	SPR	SfR	Pf%
Jan	25	6	-	6	24.00	24.00	100.00
Feb	35	7	3	4	20.00	11.43	57.14
Mar	20	6	2	4	30.00	20.00	66.66
Apr	39	10	5	5	25.64	12.82	50.00
May	48	10	6	4	20.83	8.33	40.00
Jun	43	4	2	2	9.30	4.65	50.00
Jul	129	37	17	20	28.68	15.50	54.05
Aug	129	54	17	37	41.86	28.68	68.52
Sep	173	100	74	26	57.80	15.03	26.00
Oct	79	49	12	36	62.03	45.57	73.47
Nov	210	130	23	106	61.90	50.48	81.54
Dec	74	52	2	50	70.27	67.57	96.15
Total	1004	465	163	300	46.31	29.88	64.52

Population 1450; Annual parasite incidence (API) : 320.69; Annual blood examination rate (ABER): 69.24; Slide vivax rate (SvR %): 16.24

hill stream and its tributaries. Flooding isolate these villages during the rainy season and create vast areas for mosquito breeding.

A total of 921 An.culicifacies and 28 An.fluviatilis were dissected (Table 9) of which 3 An.culicifacies were found to be positive for Plasmodium. An.fluviatilis was not found positive. Although An.culicifacies is well known to be predominantly zoophilic and An.fluviatilis is predominantly anthropophilic. In the present study, the role of An.fluviatilis could not be established in malaria transmission because only a small number of mosquitoes were collected and dissected. It is however, likely that An.fluviatilis may be an important vector along with An.culicifacies. Further studies are needed to elucidate the role of An.fluviatilis in the perennial transmission of malaria.

Parasitological studies

Occurrence of new parasite from tribal area of Madhya Pradesh: During routine epidemiological surveys undertaken in Bizadandi PHC, large number of blood smears were examined. Initially in thin films identified as P.vivax, we occasionally infected erythrocytes with multiple infection was observed. Close monitoring of slides with multiple infection revealed some distinct morphological characteristic which are not characteristic of P.vivax. The distinguishing features of infection with abnormal parasite are its microscopic resemblance with P.ovale. RBC with crenated margin either enlarged or not is one of the characteristic feature. The stippling are not seen in the ring form but are granular and prominent in later stages of development. Ring form contains an accessory chromatin often within the vacuole. The enlarged host cell is generally distorted or oval in shape. Band form trophozoites and multiple invasion of host cell is common with occasional presence of expelled parasites. Two blood samples one from P.vivax group and another from abnormal parasite group were sent to PHLS Malaria Reference Laboratory, London School of Hygiene and Tropical Medicine, London, where the patients blood were examined by molecular genetic techniques (Warhaust, 1993 personal communication). These samples were amplified using polymerase chain reaction (PCR). The primers used for this amplification were from CSP gene of P.vivax; AL60 (GTCGGAATTCATGAAGAACTTCATTCTC) AND AL61 (CAGCGGATCCTTAATTGAA-TAATGCTAGG). Samples from both groups produced amplified products indicating the presence of P.vivax in each. This amplified product was hybridized with the probes for type 1 repeat AL116 (GGTGATAGAGCAGATGGA), TYPE 2 REPEAT AL114 (ATCAACCAGGAGCAAATG) AND P.simiovale repeat sequence AL240 (AGGTGGAGCAGCAGC)[1]. The hybridization results showed that the P.vivax group contain type 2 repeats only, whereas the abnormal parasite group contain both type 1 and type 2 variants of P.vivax as well as P.simiovale

TABLE 9: MANDLA: DISSECTION DATA OF FOOTHILL VILLAGES FROM JULY TO NOVEMBER 1993

Months	An. culicifacies		An. fluviatilis	
	Dissected	Positive	Dissected	Positive
Jul	142	2	1	0
Oct	333	0	10	0
Nov	446	1	17	0
Total	921	3	28	0

Dissection could not be done due to severe flooding in August-September

TABLE 10: MANDLA: AGE AND SEXWISE DISTRIBUTION OF 52 PATIENTS WITH CEREBRAL MALARIA

Age range	Male	Female	Total
15-25	8(1)	9(4)	17
25-35	7(5)	4(3)	11
35-45	5(3)	8(4)	13
45-55	3(2)	4(1)	7
>=55	1(1)	3(1)	4

Figures in parentheses indicate number of patients died.

like parasite. P.simiovale was originally found in Macaca sinica in Sri Lanka (Dissanaike et al, 1965). Since, we are recording large number of cases from 1989 onwards, it is doubtful whether monkey malaria parasite could infect man. Further studies will show whether it is a member of P.vivax species complex or a new species of human malaria parasite. The discovery of a new parasite infecting man opens up new opportunities and challenges in malaria research and control. Areas of immediate interest are the global distribution of parasite, its evolutionary significance, transmission dynamics and molecular biology. This is important for vaccine development, because failure to deal with such variations could result in incomplete protection by vaccine.

Cerebral malaria among adults (Hospital based study): Despite the importance of surveillance by NMEP in monitoring the efficacy of malaria control programme a number of problems limited the reliable assessment of the incidence of malaria cases and death due to malaria. In Madhya Pradesh, where basic laboratory equipments and trained man power are generally not

available, diagnosis of the malaria is usually based on clinical symptoms without blood smear examination. In endemic areas, especially in adults malaria infection is not always associated with clinical symptoms because of the development of immunity. Therefore, to quantify the impact of the disease in a large urban city of Madhya Pradesh, a hospital based study on cerebral malaria among adult admitted in medicine ward of the Government Medical College, Jabalpur was carried out.

During 1993, over 1050 patients with fever were admitted in the medicine ward of the Government Medical College Hospital, Jabalpur. Out of these 52 patients (5%) had cerebral malaria (24 male and 28 female, Table 10) of which 27 died (52%). 12 had more than 20 % parasitaemia (all died) and 14 cases had parasitaemia between 10-15 %. This study indicates that cerebral malaria occur in adult with considerable frequency. The mortality rate was higher in patients with associated complications such as delay in diagnosis and treatment, hyper-parasitaemia and hypoglycemia. (Table 11).

Ecological studies

Impact of Narmada project on the transmission of malaria: Narmada, though a monsoon river is the fifth largest river of

TABLE 11: MANDLA: COMPARISON OF PRESENTING SYMPTOMS AND CLINICAL FINDINGS IN CEREBRAL MALARIA PATIENTS*

Presenting symptoms/ clinical findings	Total cases	Improved cases (%)	Died cases (%)
Fever	52	25 (48.1)	27 (51.9)
Headache	20	8 (40.0)	12 (60.0)
Chills/rigor	50	23 (46.0)	27 (54.0)
Vomiting	14	10 (71.4)	4 (28.6)
Convulsion	11	1 (9.09)	10 (90.9)
Bodyache	40	18 (4.50)	22 (55.0)
Abdominal pain	9	5 (55.5)	4 (44.5)
Diarrhoaea	4	2 (50.0)	2 (50.0)
Bleeding	3	-	3 (100)
Dark urine	1	1 (100)	-
Severe anaemia	16	6 (37.5)	10 (62.5)
Oligourea/Renal failure	8	2 (25.0)	6 (75.0)
Jaundice	4	1 (25.0)	3 (75.0)
Hypoglycemia	7	1 (14.3)	6 (85.7)
Hyper-parasitaemia	21	6 (28.6)	15 (71.4)
Unconsciousness/ Deep coma	45	18 (40.0)	27 (60.0)

* Improved/died

India. It originates from Amarkantak in District Shahdol of Madhya Pradesh. Out of its total length of 1312 kms, it runs for about 1112 km in the state of Madhya Pradesh through the districts of Shahdol, Mandla, Jabalpur, Hoshangabad, Khandwa, Khargone, Dhar and Jhabua. More than 80 lakh population of Madhya Pradesh is living on the banks of the river and its distributaries. Since bulk of the run-off comes in a few months of monsoon due to few spells of intense and heavy rainfall, conservation of water by way of creating storages is the only option to meet the ever growing needs of the population of our country. To utilise the Narmada waters it is proposed to construct 29 major, 135 medium and 3000 minor projects to irrigate 27.55 lakh ha of land, to generate 3000 MW of power and to provide water for domestic and industrial use. Out of 29 major projects, 3 projects have been completed and 3 are nearing completion. Bargi dam is the first dam on Narmada and construction was started in way back 1974 in district Jabalpur. The total length of the dam is 5.4 km. The main left bank canal is 137 km (78 km has already been constructed) and total length of the canal along with distributaries is about 3645 km. It is proposed to construct 100 km long right bank canal also to irrigate another 62000 ha land. owing to dam construction 162 villages of Jabalpur, Mandla and Seoni district have come under submergence.

Ten villages situated in the command area of left bank canal were selected for preliminary studies. Out of ten, five are head-enders (population 2191) and five are tail-enders (population 4034). The terrain is undulating and people are predominantly scheduled caste and scheduled tribes. The majority of the families are involved in agricultural activities for their livelihood. There is partial employment in forestry sector. Since the area is hilly with different terrain, agriculture is rainfed and normally single crop is raised. Most villagers work in stone craushers/road construction sites for their livelihood during dry months of the year. Under such situation irrigation projects could be expected to have considerable impact on the ecology of the area. Malaria is a major vector-borne disease that is linked with the water supply and irrigation. Lack of proper spent water disposal, water stagnation and poor drainage have enormously affected breeding of vector mosquitoes and in turn transmission of malaria. Malaria problem exist mainly in water channels, canals, branches and distributaries as the total length of channels in a single irrigation system could be over a thousand miles.

Breeding site survey: Mosquito breeding is rarely seen in canals if a flow is maintained but when the water supply is cut-off profuse breeding is recorded. When the supply of water is again turned-on, innumerable larvae are driven into the inhabited areas through distributaries. Thick vegetation growth of aquatic weeds around regulators and bridges not only

TABLE 12: MANDLA: COMMON BREEDIING SITES AND THEIR ANOPHELINE PRODUCTIVELY IN BARGI PROJECT AREA

Breeding sites	Emergent species *			
	Total anopheles	An. culicifacies	An. stephensi	An. annularies
(A) Breeding sites near dam site				
Main impoundment and isolated pools	0	0	0	0
Stream terminating into impoundment supported with profuse seepage	155	134	6	0
Seepage down to dam	114	113	1	0
Canal with dense vegetation	113	27	0	86
Burrow pits	5	5	0	0
(B) Command area				
Canal, Major	12	9	0	3
Canal, Minor	2	1	0	0
Ponds	1	0	0	1
Seepages	3	0	0	3
Pools	13	8	1	2
Streams	4	1	1	2
Ditch	1	0	0	0

* Other species were found in small numbers

TABLE 13: MANDLA: EPIDEMIOLOGICAL RESULTS OF VILLAGES UNDER BARGI CANAL STUDY (OCTOBER - DECEMBER 1993)

Villages (5villages irrigated by canal)	Population	BSE	Pv	Pf	+ve	SPR	SfR	Pf %
Head-enders	2191	774	19	131	150	19.4	17.0	87.3
Tail-enders	4034	357	10	64	74	21.0	18.0	86.5

obstruct free flow of water it also supports heavy breeding. The filamentous green algae poses serious problem in irrigation canals by attaching to canal lining thus reducing their carrying capacity.

Important breeding sites are shown in Table 12. Indoor resting collections revealed the presence of 11 species with three vector species i.e. An.culicifacies, An.fluviatilis and An. stephensi. Of which only An.culicifacies was found prevalent throughout the year in high density.

Preliminary epidemiological surveys revealed that prevalence of malaria is very high particularly of P.falciparum (Table 13).

(IX) SONAPUR, KAMRUP DISTRICT, ASSAM

In the preceding year, besides regular passive case detection (malaria clinic) in Sonapur PHC, malaria surveys were conducted in endemic tea estates of Assam to determine malaria incidence, sensitivity to chloroquine, and to study vector bionomics. Field trials with Neem oil (Azadirachta indica) were also conducted to ascertain its relative efficacy as personal protection measure against An. minimus, and other biting mosquitoes. Further, to promote methods of bioenvironmental control of malaria, two workshops, and a seminar were organized for State/Defence personnel and tea garden doctors respectively along with other health education activities, viz., group meetings, video shows, health camps etc. (Table 1).

Epidemiological observations

Active case detection : Weekly active surveillance were continued in 50 villages till Dec. I992 (for 3 months) during which 1498 blood smears were collected of which 435 were malaria positive. SPR ranged from 24% to 34%, and 79% were *Pf* infections (Table 2).

Passive case detection : In the malaria clinic, 5453 blood smears were collected of which 39%' were malaria positive, there was preponderance of fever cases during June to September coupled with rise in *Pf* cases. SfR was 28% and it ranged from 7% to 39% (Table 3).

TABLE 1: SONAPUR: PROGRESS AT A GLANCE *

Health camp	:	1
Group meetings	:	14
Video shows	:	12
T.V. coverage (regional)	:	1
Workshops (3 days) on malaria	:	2
Seminar (1 day) on malaria	:	1
News clips (regional)	:	3

* From: October 1992 - September 1993

TABLE 2: SONAPUR: RESULTS OF ACTIVE SURVEILLANCE

Month/Year	BSC/E	+ve	Pf	SPR	Pf%	MPI	BER
Oct'92	576	139	109	24.13	78.41	6.19	2.36
Nov'92	528	163	136	30.87	83.43	7.25	2.35
Dec'92	394	133	100	33.75	75.18	5.92	1.75
Total	1498	435	345	29.03	79.31	19.37	6.67

Population - 22452

TABLE 3: SONAPUR: PASSIVE CASE DETECTION AT MALARIA CLINIC

Month/Year	BSC/E	+ve	Pf	Pv	SPR	SfR
Oct '92	441	182	135	47	41	31
Nov '92	341	163	133	30	48	39
Dec '92	238	115	82	33	48	34
Jan '93	184	101	65	36	55	35
Feb '93	176	62	28	34	35	16
Mar '93	252	66	17	49	26	7
Apr '93	231	94	48	46	41	21
May '93	432	162	106	56	37	25
Jun '93	721	213	149	64	29	21
Jul '93	819	350	278	72	43	34
Aug '93	827	359	290	69	43	35
Sep '93	791	280	208	72	35	26
Total	5453	2147	1539	608	39	28

Mass Blood Surveys : In the cross-sectional mass blood surveys in endemic villages, malaria positives were recorded both in febrile and afebrile cases. Of the total 3677 blood smears examined, 10% were malaria positive mostly being *Pf* (75%) (Table 4).

Relapsing pattern of P. vivax : Since there is a perennial transmission, and man/vector contact is very high, primaquine was not administered as radical treatment in *Pv* infections. Keeping this in view, 479 cases were followed to study relapse rate during 1992, of which 42 cases (8.76%) relapsed (Table 5). Further studies are in progress.

Malaria surveys in tea estates : Malaria surveys were conducted in a number of tea estates (T.E.) located in Mangaldai, Tezpur, Biswanath, Nagaon and Dhubri circles of Ahita (Zone 3). Data were

TABLE 4: SONAPUR: RESULT OF MASS BLOOD SURVEY

Month/year	Febrile			Afebrile			Total			Indices		
	BSC/E	+ve	Pf	BSC/E	+ve	Pf	BSC/E	+ve	Pf	SPR	SfR	%Pf
Oct '92	44	8	6	281	37	25	325	45	31	13.84	9.53	69.00
Nov '92	82	32	26	293	68	60	375	100	86	26.66	23.00	86.00
Dec '92	53	26	16	284	32	21	337	58	37	17.21	10.97	63.79
Jan '93	-	-	-	1287	124	96	1287	124	96	9.63	7.45	77.41
Feb '93	-	-	-	1354	42	26	1354	42	26	3.10	1.92	61.90
Total	179	66	48	3499	303	228	3677	369	276	10.03	7.50	74.79

TABLE 5: SONAPUR: RELAPSING PATTERN OF P. VIVAX (TREATED WITH CHLOROQUINE ONLY)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	% Relapse
(30)	0	1	2	0	0	0	0	0	0	0	0	3	10.00
	(15)	1	1	0	0	0	0	0	0	1	0	3	20.00
		(15)	2	0	1	0	0	0	0	0	0	3	20.00
			(19)	0	0	1	0	0	0	0	0	1	5.26
				(44)	0	1	0	1	0	0	0	2	4.54
					(52)	0	1	0	0	1	0	2	3.84
						(61)	0	2	3	1	1	7	11.47
							(79)	1	4	0	1	6	7.59
								(54)	6	4	1	11	20.37
									(47)	1	2	3	6.38
										(30)	1	1	3.30
											(33)	-	-
Total	479											42	8.76

Study period = 1992; Total cases = 479; Relapse case = 42; % Relapse = 8.76; Figures in parentheses are the primary attacks

TABLE 6: SONAPUR: PASSIVE CASE DETECTION IN TEA ESTATES OF ASSAM (ZONE 3)

Circle	Name of Tea Estate	Study period	Malaria incidence				Indices
			BSC/E	+ve	Pf	SPR	%Pf
Mangaldai	Paneery	Jul'92-Aug'92	2953	1657	1399	56	84
		Apr'93-Jun'93	1090	516	377	47	73
	Bhootiachang	Jul'92-Aug'92	639	222	147	35	66
	Barangajulie	Jul'92-Aug'92	685	303	238	44	78
	Corramore	Dec'92-Jan'93	683	293	142	43	48
	Dimakuchi	Jul'92-Aug'92	70	29	22	41	76
	Attarikhat	Jul'92-Aug'92	355	194	164	55	84
	Total		6475	3214	2489	50	77
Tezpur	Tarajulie	May'92-Jun'92	1071	374	288	35	77
	Kolony	May'93-Jun'93	417	50	39	12	78
	Sonajulie	May'93-Jun'93	121	19	15	16	79
	Naharani	May'93-Jun'93	14	7	6	50	86
	Total		1623	450	348	28	77
Biswanth	Majuligarh	Aug'93-Sep'93	1129	249	228	22	92
	Monabari	Aug'93-Sep'93	11	1	1	9	100
	Gingia	Aug'93-Sep'93	23	3	3	13	100
	Pabhai	Aug'93-Sep'93	24	8	7	33	87
	Helem	Aug'93-Sep'93	6	-	-	-	-
	Baghmari	Aug'93-Sep'93	10	-	-	-	-
	Pratapghar	Aug'93-Sep'93	12	5	4	42	80
	Total		1215	266	243	22	91
Nagaon	Kondoli	Oct'93-Nov'93	425	99	33	23	33
Dhubri	Choibari	Sep'93-Oct'93	1000	390	268	39	69

TABLE 7: SONAPUR: MASS BLOOD SURVEYS IN DIFFERENT TEA ESTATES OF ASSAM

Name of the T.E.	District	BSC/E	+ve	Pf	SPR	SfR	%Pf
Paneery	Darrang	736	157	141	21.33	19.15	89.80
Corramore	Darrang	1150	235	141	20.43	12.26	60.00
Tarajulie	Sonitpur	1359	249	240	18.32	17.66	96.38
Kolony	Sonitpur	1392	35	24	2.5	1.7	68.57
Majuligarh	Sonitpur	165	6	5	3.63	3.03	83.33
Naharani	Sonitpur	423	5	5	1.18	1.18	100.00
Choibari	Dhubri	999	93	77	9.30	7.70	82.79
Kondoli	Nagaon	89	17	12	19.10	13.48	70.58
Total		6313	797	645	12.62	10.21	80.92

collected on malaria incidence, sensitivity to chloroquine in *Pf*, and prevalence of anophelines/vectors, and their bionomics.

Passive case detection (malaria clinic): Blood smears were collected from the fever patients in OPD and examined for malaria parasite. In the Mangaldai circle, all the gardens surveyed were highly malaria endemic. Of the 6475 blood smears examined, 50% were malaria positive, and 77% were *Pf* infections (Table 6). In tea estates of Tezpur circle, Tarajulie T.E. was most affected. Of 1071 blood smears examined, 35% were malaria positive, and *Pf* was the predominant species. In the Biswanath circle of gardens, Majuligarh T.E. had sudden spurt of *Pf* cases (previously silent areas). Of the 1129 blood smears examined, 22% were malaria positive, mostly being *Pf*. In Kondoli T.E. (District Nagaon), SPR was 23%, however, *Pv* was the predominant species (67%). In Choibari T.E. (District Dhubri), SPR was 39% and 69% were *Pf* infections.

Mass blood surveys: Cross-sectional mass blood surveys were also conducted in some gardens to determine endemicity. Tea estates of districts Sonitpur and Darrang were *Pf* endemic. Positives were recorded both in febrile and afebrile cases. SPR ranged from 1.18% to 21%, and 60 to 96% were *Pf* (Table 7). All other tea estates appeared to have moderate endemicity.

Chloroquine sensitivity in Pf: In the hospital based study using 3 day (D0, D4, D7) <u>in-vivo</u> test, 107 cases were followed, of which 92 (86%) were S/RI, 9 (8%) were RI, 4 were RII, and 2 were RIII respectively. Thus, tea garden tribes were by and large chloroquine sensitive (Table 8).

<u>Entomological observations</u>

Day resting collections: In the day resting catches from human dwellings (indoor), 11 anophelines species were recorded from

TABLE 8: SONAPUR: CHLOROQUINE SENSITIVITY IN <u>Pf</u> INFECTIONS IN TEA GARDEN POPULATIONS (3 DAY STANDARD WHO TEST)

Name of the T E	Total cases	S/RI	RI	RII	RIII
Tarajulie	40	32	4	2	2
Paneery	63	56	5	2	0
Corramore	4	4	0	0	0
Total	107	92	9	4	2

Study period: 1992

TABLE 9: SONAPUR: ANOPHELINE FAUNA IN TEA ESTATES OF ASSAM

S.No.	Species	Tea estates (Day resting catches in house dwellings)								
		Majulighar (Man Hours = 66)			Choibari (Man Hours = 75)			Kondoli (Man Hours=51)		
		No. collected	MHD	% of Total	No. collected	MHD	% of Total	No. collected	MHD	% of Total
1.	An. aconitus	1	0.01	0.10	-	-	-	-	-	-
2.	An. annularis	14	0.21	1.38	9	0.12	0.53	3	0.06	0.52
3.	An. barbirostris	-	-	-	-	-	-	2	0.04	0.35
4.	An. jeyporiensis	-	-	-	-	-	-	4	0.08	0.69
5.	An. karwari	1	0.01	0.10	-	-	-	-	-	-
6.	An. kochi	1	0.01	0.10	-	-	-	-	-	-
7.	An. minimus	2	0.03	0.20	-	-	-	22	0.43	3.82
8.	An. nigerrimus	-	-	-	-	-	-	2	0.04	0.35
9.	An. subpictus	-	-	-	1	0.01	0.06	-	-	-
10.	An. vagus	991	15.01	98.12	1692	22.56	99.41	542	10.52	94.10
11.	An. varuna	-	-	-	-	-	-	1	0.02	0.17
		1010	15.28	100.00	1702	22.69	100.00	576	11.19	100.00

MHD: Man Hour Density
From August to November, 1993

three different tea estates (Table 9). Of these, An. vagus was the most predominant. All other anophelines were in low proportions including An. minimus. The man hour density (MHD) for total anophelines ranged from 11.19 to 22.69 per man hour. All these species were collected while resting on walls, from hanging clothes and other articles within the house.

Whole night collections: In the whole night catches (1800 to 0500 h), 10 different anopheline species were collected over human bait in three different tea estates (Table 10). In Majuligarh T.E. (District Sonitpur), An. splendidus was the predominant species (35.29%), while An. minimus comprised only (17.67%) of total collection. In Choibari T.E. (District Dhubri), An. philippinensis comprised the major proportion while An. minimus was not encountered. In Kondoli T.E. (District Nagaon), also An. philippinensis was most prevalent, An. minimus contributed 21% of total collection. Man biting rate (MBR) for An. minimus varied from 0 to 2.33, and for total anophelines 3.69 to 11.00 per man per night.

Vector incrimination: Although An. minimus have already been incriminated in Tarajulie T.E. (District Sonitpur), and Panerry T.E. (District Darrang), An. minimus could not be incriminated in Majuligarh T.E., Choibari T.E. and Kondoli T.E. This is attributed to low collection and DDT spray just prior to study period in the aforementioned tea estates.

Other studies

Neem oil as repellent: A field trial: Field trials with Neem (Azadirachta indica) oil were conducted as repellent against the principal vector of malaria, An. minimus and other mosquitoes in endemic villages of Sonapur PHC. Neem oil mixed with mustard oil at varying concentration of 0.1%, 0.5%, 1% and 5% was applied on exposed body parts of human baits. Two to five ml of oil was applied on each bait. Whole night collections (4 man nights) were made keeping appropriate controls. It was observed that increasing protection was conferred against mosquito bites at 2% concentration onwards. At 5% concentration, protection between 80 and 90% was achieved against culicines and An. minimus both (Figs. 1, 2).

Species composition of Aedes albopictus subgroup: Ae. albopictus vector for dengue virus is comprised of several species having varying distribution in N.E. region. Larva and man biting collections were made in various parts of Assam to identify various species of this subgroup and their relative abundance. The most common species was Ae. novalbopictus (99%), and only a few specimens of Ae. pseudoalbopictus were captured. These two species were found breeding in bamboo holes, tyres, flower earthern pots and tar drums. Efforts were made to colonize these species but all in vain. Further studies are in progress.

TABLE 10: SONAPUR: RECORDS OF WHOLE NIGHT MAN BITING CATCHES IN TEA ESTATES OF ASSAM

S.No.	Species	Tea Estates								
		Majulighar (Man Nights= 4)			Choibari (Man Nights= 5)			Kondoli (Man Nights=3)		
		No. collected	MHD	% of Total	No. collected	MHD	% of Total	No. collected	MHD	% of Total
1.	An. aconitus	3	0.75	17.67	-	-	-	1	0.33	3.03
2.	An. annularis	-	-	-	3	0.60	16.67	-	-	-
3.	An. barbirostris	1	0.25	5.88	-	-	-	2	0.67	6.06
4.	An. jeyporiensis	3	0.75	17.67	-	-	-	5	1.67	15.15
5.	An. karwari	-	-	-	1	0.20	5.56	-	-	-
6.	An. kochi	-	-	-	1	0.20	5.55	-	-	-
7.	An. minimus	3	0.75	17.67	-	-	-	7	2.33	21.21
8.	An. philippinensis	1	0.25	5.88	12	2.40	66.67	16	5.33	48.49
9.	An. splendidus	6	1.50	35.29	1	0.20	5,55	-	-	-
10.	An. varuna	-	-	-	-	-	-	2	0.67	6.06
		17	4.25	100.00	18	3.69	100.00	33	11.00	100.00

MBR : Man biting rate per man per night
From August to November, 1993

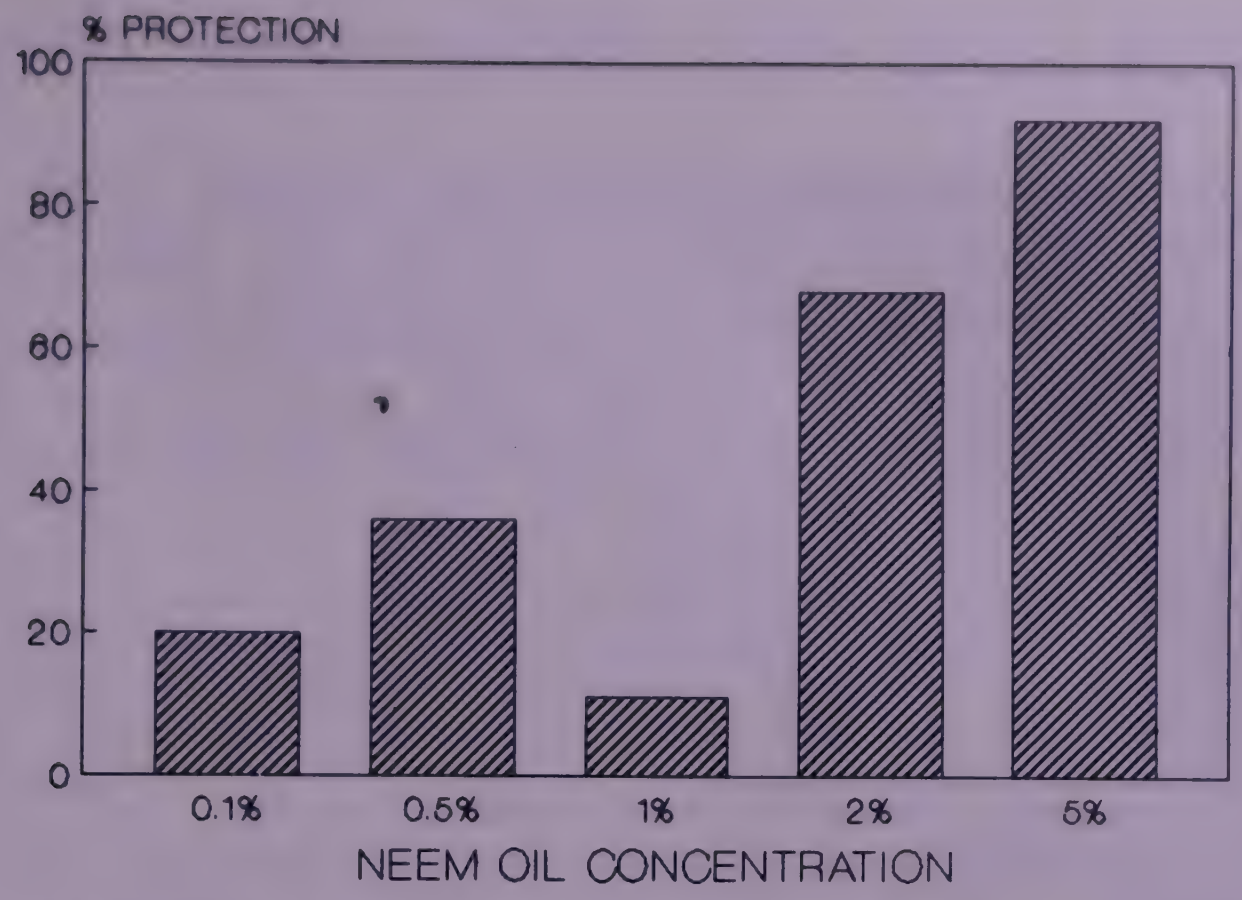


Fig. 1: Sonapur: Relative protection against Anopheles minimus with topical application of Neem oil over human bait in varying concentrations in malaria endemic villages of Sonapur PHC (data based on four man nights)

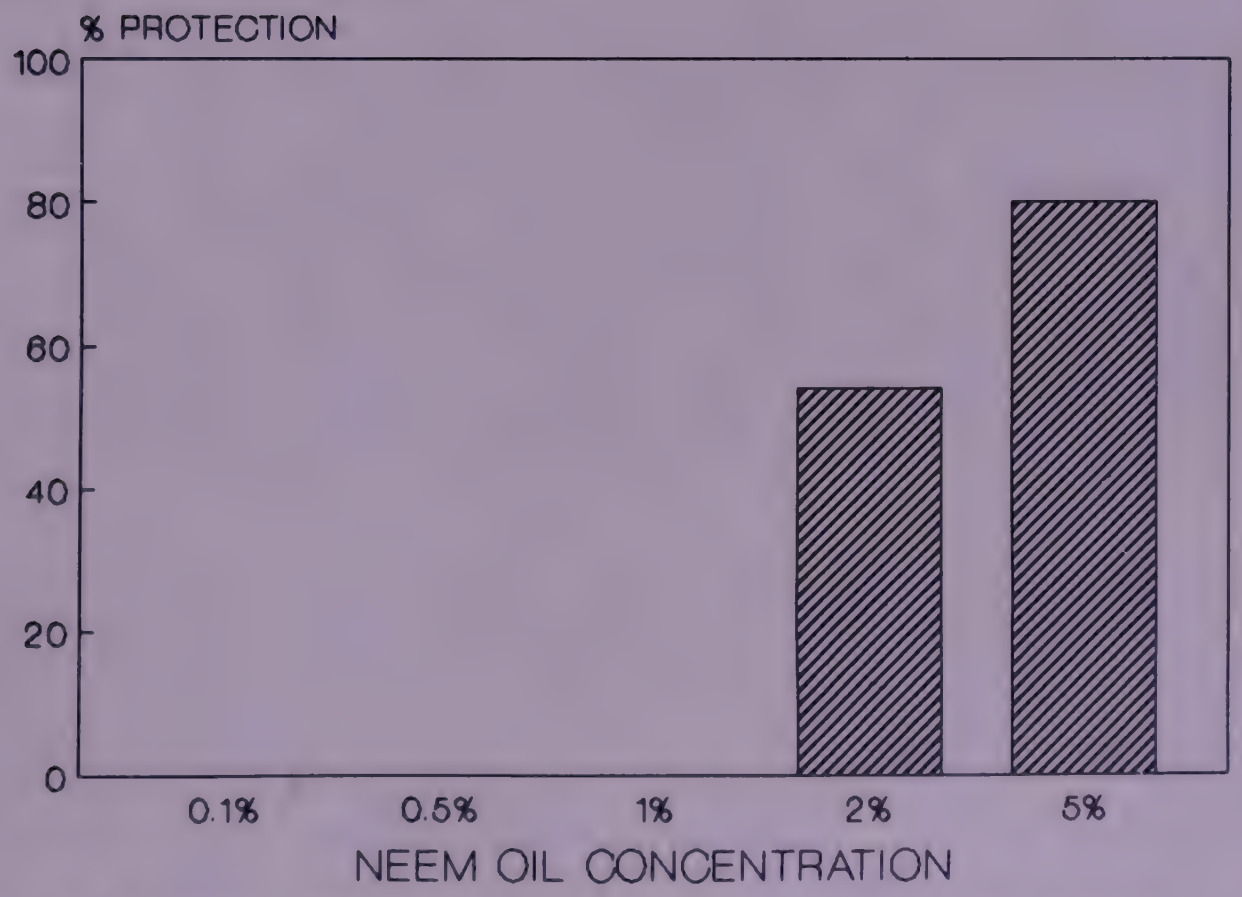


Fig. 2: Sonapur: Relative protection against culicines with topical application of Neem oil over human bait in varying concentrations in villages of Sonapur PHC (data based on four man nights)

Collaborative projects

Siblings of Anopheline species: To study siblings of An. minimus and An. fluviatilis (the vector species), live adults were sent to Delhi regularly for chromosome analysis and enzyme variation studies. Blood smears of fed mosquitoes were also examined for host blood meal analysis. Blood samples from malaria positive cases were collected for parasite bank to study host parasite immune response and chloroquine sensitivity studies in vitro.

(X) ROURKELA, DISTRICT SUNDERGARH, ORISSA

The field station at Rourkela was established in 1988 with the objectives to (a) conduct applied field research on malaria; (b) develop and demonstrate appropriate disease vector control methods; (c) study socio-economic aspects of malaria and (d) facilitate transfer of technology to users.

Within these broad objectives it has been attempted to develop appropriate bioenvironmental measures of malaria control and where these are not practicable, other suitable approaches are being tested. During the year under reference a three year feasibility-cum-demonstration project on pyrethroid impregnated bednets to control malaria was completed. Another project in the mining areas is under implementation. A study on mosquito breeding in relation to rice agro-ecosystems is underway while in urban areas of Rourkela two bio-larvicides are being tested for mosquito control. A study on the role of haemoglobinopathies and enzymopathies in malaria has been initiated in tribal area. The progress of these studies is mentioned in this report.

Evaluation of Pyrethroid Impregnated Bednets for Malaria Control

Bednet trial in Kuarmunda PHC: The study which was launched in Kumjharia section (pop. 6100) of Kuarmunda PHC in May 1990 and was completed in April 1993. Prior to the bednet study high incidence of malaria was being reported from this particular section. This was apparently due to good surveillance (ABER 53.4%) and case detection (SPR 44.7%; API 238) as can be judged from the data collected from May 89 to April 90. Major malaria vectors in the study area are Anopheles culicifacies and An. fluviatilis. In our earlier whole night studies it was found that about 77% of biting of all An. culicifacies and 92% of An. fluviatilis takes place between 2000 and 0400 h. Hence, it justified the usages of bednets for personal protection against malaria.

The study area was divided into five groups of comparable endemicity. Bednets treated (@ 25mg/sq.m) with lambdacyhalothrin 5% EC (pop.1220), deltamethrin 2.5% WP (pop.1850), deltamethrin 2.5% flow (pop.1100) were provided to three different groups, the fourth group received untreated nets (pop.1403) while the fifth no nets (pop.814). To begin with, the bednets were impregnated manually by dipping/kneading, dried in shade and distributed house-to-house as per the requirement based on sleeping pattern so that all householders would have access to their usage. Lamda and delta WP impregnated nets were distributed in the last week of April 90, while delta flow impregnated nets in the last week of October 90.

Malaria incidence as recorded through the routine surveillance by PHC from May 89 to April 90 was taken as baseline incidence, except for delta flow area whose baseline data were generated by MRC from November 89 to October 90.

TABLE 1: ROURKELA: IMPACT OF BEDNET INTERVENTION ON MALARIA IN KUARMUNDA PHC (DISTRICT SUNDERGARH)

Parameter	Area	Baseline year *	Intervention years			% change
			I	II	III	
API	ICON	270.7	166.5	149.9	74.6	-72.4
	DMWP	208.5	243.4	194.4	121.6	-41.7
	Untreated nets	252.5	270.8	181.5	104.8	-58.5
	No nets	223.6	437.7	329.2	227.3	+1.6
SPR	ICON	41.1	29.6	28.9	18.3	-55.5
	DMWP	46.9	36.2	28.5	28.8	-38.5
	Untreated nets	38.5	38.0	33.7	23.1	-40.0
	No nets	46.2	53.3	51.1	46.5	+1.7

* Baseline NMEP data : May'89 to Apr'90; ICON = Lambdacyhalothrin, EC; DMWP = Deltamethrin, WP

TABLE 2: ROURKELA: IMPACT OF DELTAMETHRIN IN FLOW TREATED NETS ON MALARIA IN KUARMUNDA PHC (DISTRICT SUNDERGARH)

Parameter	Area	Baseline year *	Intervention years		% change
			I	II	
API	FLOW	327.6	312.7	133.6	-59.2
	No nets	305.2	417.1	275.2	- 8.7
SPR	FLOW	46.4	37.3	26.7	-42.4
	No nets	47.8	51.6	51.9	+ 8.6

* Baseline MRC data (Nov'89 to Oct'90).

Malaria incidence during the intervention period was recorded by MRC staff through weekly surveillance.

In the no net area malaria incidence increased from API 223.6 in baseline year to 227.3 in the third year of intervention with a considerable increase in malaria during the intervening period (Table 1). The slide positivity rate (SPR) remained unchanged during the above mentioned period. As compared to this in the villages with untreated nets API decreased from 252.5 to 104.8 (-58.5%) indicating that even the plain nets did provide significant protection from malaria as compared with no nets. In the area with nets treated with lambdacyhalothrin, malaria incidence decreased by 72.5% i.e. from 270.7 API to 74.6 and SPR by 55.5%. This indicated that impregnation of nets with lambdacyhalothrin provided still superior protection from malaria as compared with untreated nets. In villages provided with nets treated with deltamethrin WP, API decreased from 208.5 to 121.6 (-41.8%).

Nets treated with deltamethrin, flow were provided in November 90. Malaria API decreased by 59% i.e. from API 327.6 during baseline year (November 89 - October 90) to API 133.6 after two years of intervention (Table 2). Compared with these, there was a marginal decrease in malaria in the no net area however, the SPR increased marginally.

Near completion of the study (February 93) the haemoglobin levels (gm/dl) in children below 10 years of age were as follows : deltamethrin flow 14.9 > lambdacyhalothrin, EC 14.5 > deltamethrin, WP 14.3 > untreated nets 11.6 > no nets 11. Therefore, the haemoglobin levels in children sleeping under treated nets were higher than those with untreated nets or without nets. All other factors being common in the population, this indicated a marked improvement in anaemia due to the drop in malaria. There was also a marked improvement in the morbidity in children below 10 years in the intervention villages as the spleen rate dropped by 81% in lambdacyhalothrin area, 86% in deltamethrin flow area and by 90% in deltamethrin WP area whereas there was increase of 35.5% in the no net area.

There were two malaria vectors in the area viz. Anopheles culicifacies and An. fluviatilis. During night bite catches (1 night per month for 12 months) using four human baits the total number of vectors collected were in the following order: no net(63), untreated net(19), deltamethrin WP(12), deltamethrin Flow (11), lambdacyhalothrin (2) In another short term experiment during eleven continuous nights the average biting rate of An.fluviatilis was 11 per man per night (baseline), however, during the next 11 nights there was no biting, when the baits slept under partially lifted nets treated with lambdacyhalothrin or deltamethrin flow, whereas the biting rates under untreated nets and no nets were 3 and 5.

(The apparent drop in biting rate under untreated nets and no nets was due to seasonal changes).

The densities of An. culicifacies in villages with treated nets were significantly lower than in control up to 6 months of impregnation. Therefore, after one year of trial impregnations were done on six monthly basis.

Intervention communities using deltamethrin WP treated nets often complained of skin and eye irritation, apparently due to powder flakes that withered during the net use. Hence, from June'92 onwards all such nets were impregnated with flow formulation. People generally provided excellent cooperation in re-impregnation of their nets which were brought by them duly washed, dried and mended, if neessary. Voluntary health committees by the people themselves ensured good compliance and supervised use and upkeep of bednets. The collateral benefits as perceived by the users of treated nets included the reduction in nuisance of houseflies, nuisance mosquitoes, head lice, bedbugs and even protection from snake and scorpion bites (also by plain net users) while sleeping on floors.

Bednet trial in mining area: District Sundergarh has over 81 major operational mines while innumerable small mines. The mines mostly have associated human settlements. The mining area selected for the study is located at an elevation of 700-800 m and receives up to 2 m annual rainfall. The temperature remains favourable (range 17 deg C - 32 deg C) throughout the year for mosquito breeding. The mosquitogenic potential of the area is high and the breeding places are mainly perennial hill streams and seepage pools. In the monsoon, the paddy fields, rainwater pools, etc. also contribute to mosquito breeding. The studies in 1989-90 revealed that the mosquito fauna in the area is rich and the major malaria vector is An.fluviatilis supported marginally by An.culicifacies.

On the request of the authorities of Rourkela Steel Plant under Steel Authority of India Limited (SAIL) another bednet trial was launched in May 1992 in three mining settlements, 100 km south of Rourkela city. In the mining settlements nets treated with cyfluthrin (5% EW) were provided to a population of 11726 in May, 1992 whereas another 2920 population without nets was kept for comparison. Bednets were re-impregnated every 6 months.

Treated nets (50 mg/sq m) provided excellent protection from the bites of An. fluviatilis (Fig. 1) as well as caused a considerable reduction in the density of An.fluviatilis (Fig. 2a), An. culicifacies (Fig. 2b), total anophelines (Fig. 3a) and total mosquitoes (Fig. 3b). This resulted significant reduction in malaria incidence (based on fortnightly surveillance) and slide positivity rate in the net area (Fig. 4a,b). During the first year of intervention malaria incidence

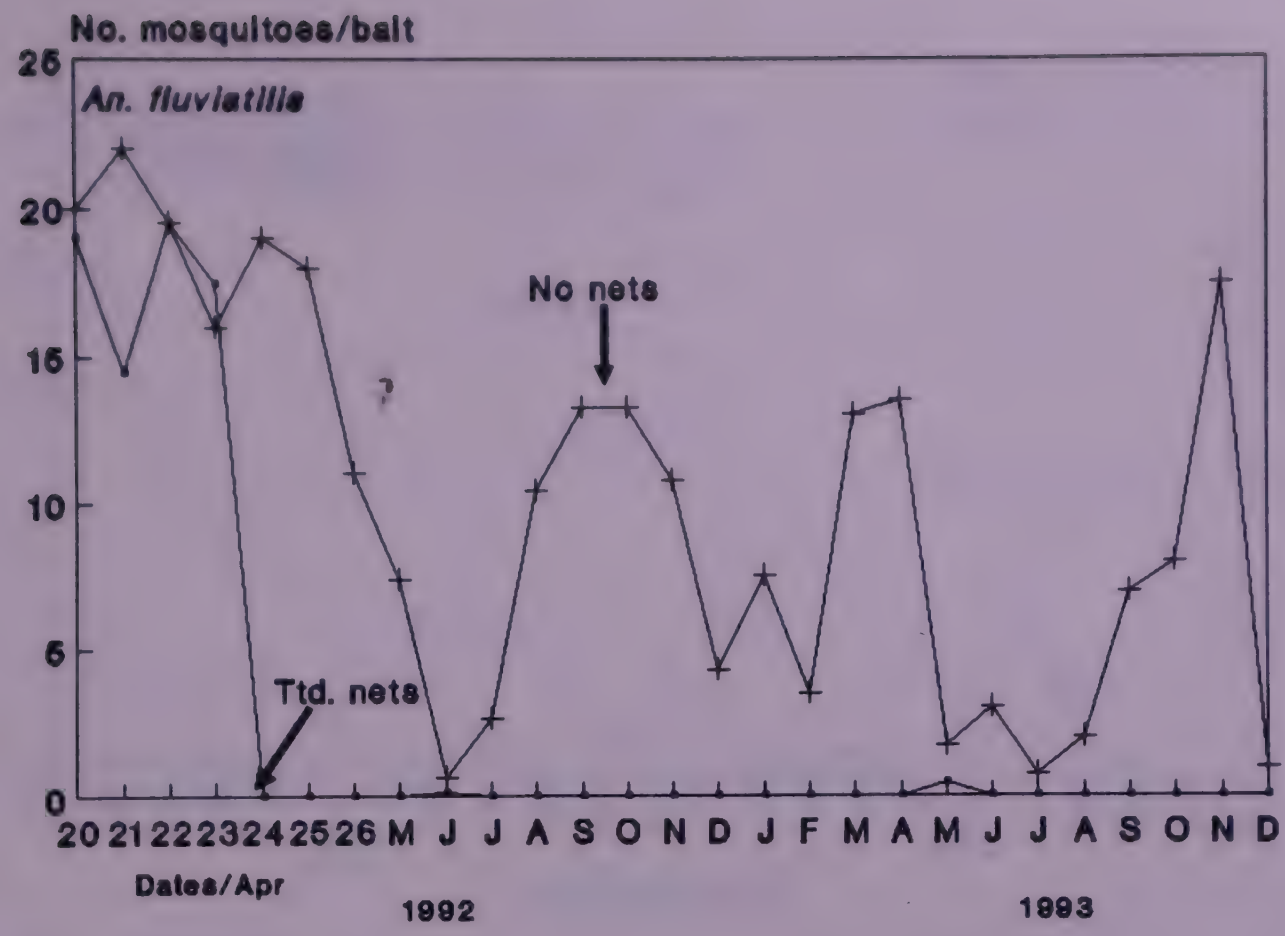
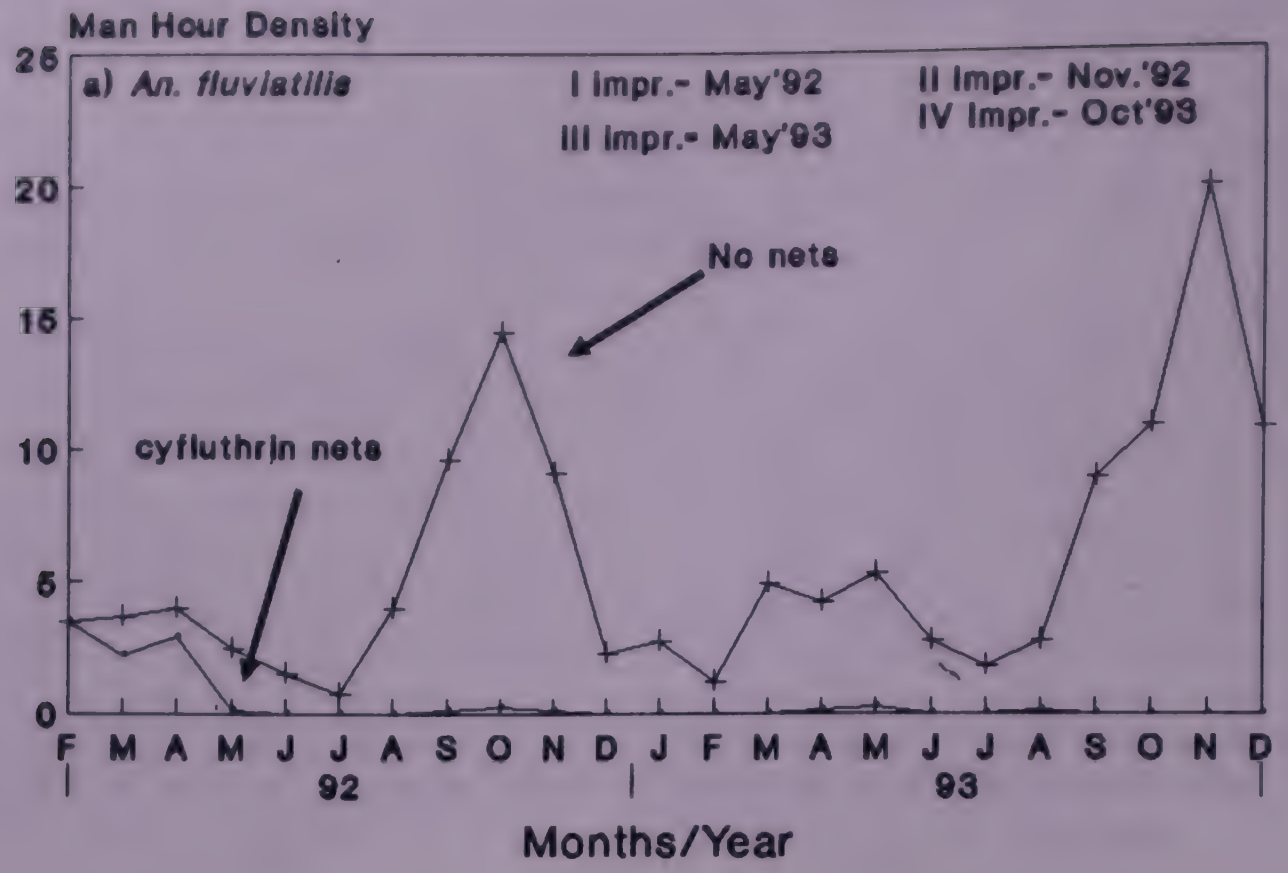


Fig. 1: Rourkela: Protection provided by partially lifted cyfluthrin impregnated bednets from the malaria vector An. culicifacies as compared with no nets

(API) in bednet area was 100 compared with 223 in control. During next 8 months of second year cumulative incidence in former area was 43.7 as compared to 130 in control.

A remarkable impact was also observed on the bed occupancy due to malaria in the two mining hospitals (Fig.5) i.e. from 604 malaria cases admitted during baseline year (May'91 to April'92) to 303 cases (49.8% reduction) during the first year of intervention. The reduction is continuous in the 2nd year of the trial also. In other words, the bed occupancy dropped from an average of 50 cases per month to 25 cases per month and to 14 cases during the 2nd year (8 months data). This is likely to have tremendous savings on treatment expenditure and economic loss due to wages etc. In the net area health education was also given by organising group meetings (109), video shows (8), exhibitions (3), writing wall slogans etc. The study is under progress.

Because of the tremendous success of this strategy, large number of requests are pouring in from various mines in the region for adopting the strategy. Considering their requests plans are under way to survey other mines for preparing action plans for malaria control.



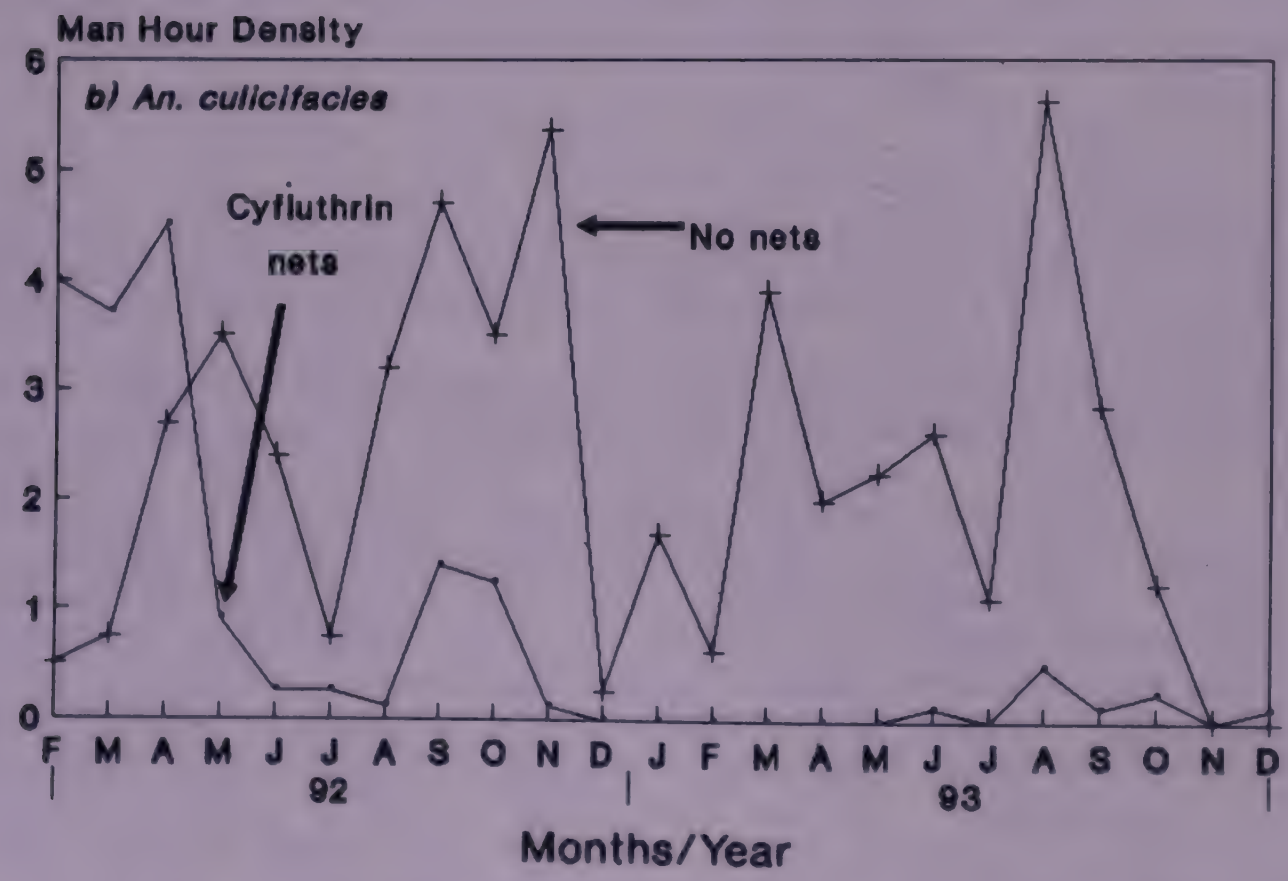
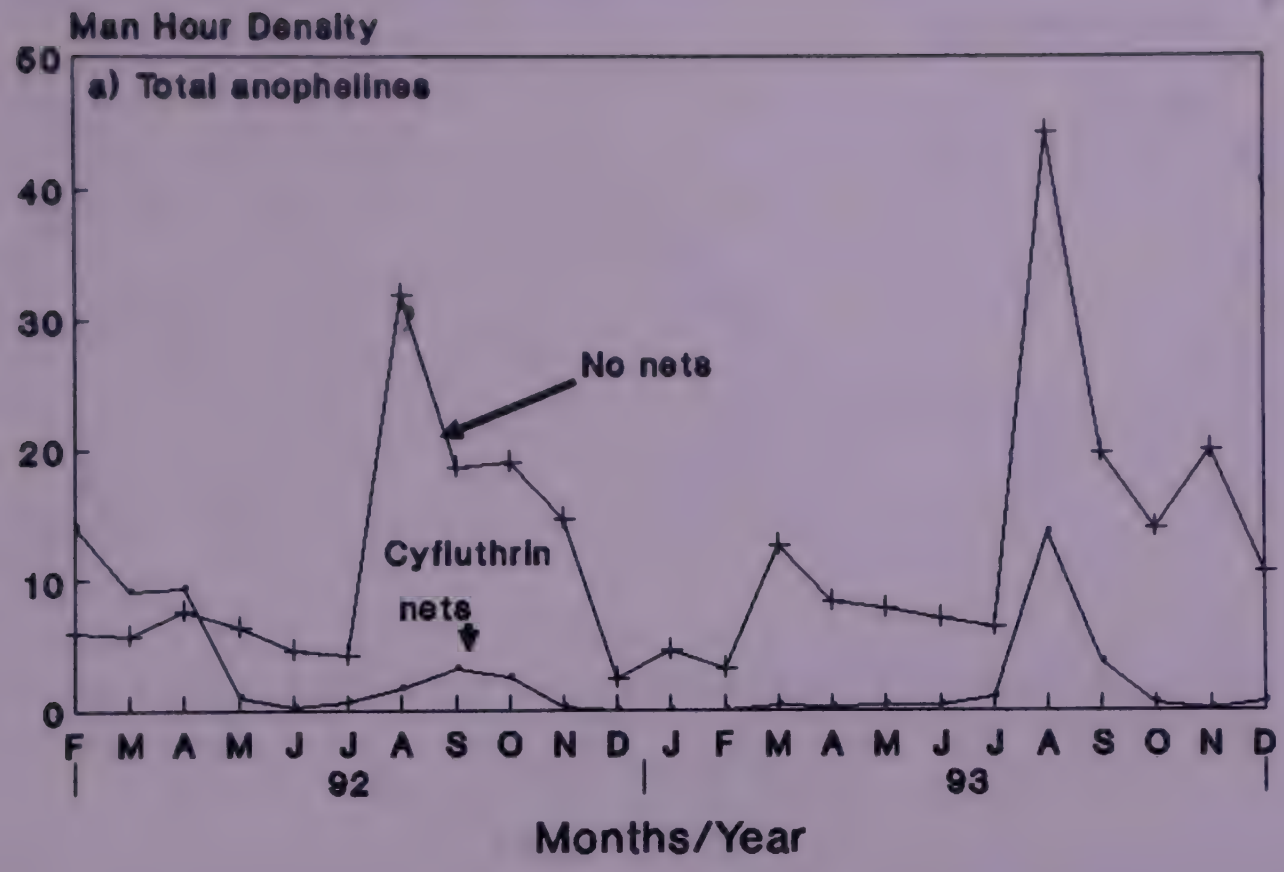


Fig. 2: Rourkela: Indoor density of (a) An. fluviatilis and (b) An. culicifacies in the bednet area and control (without nets)



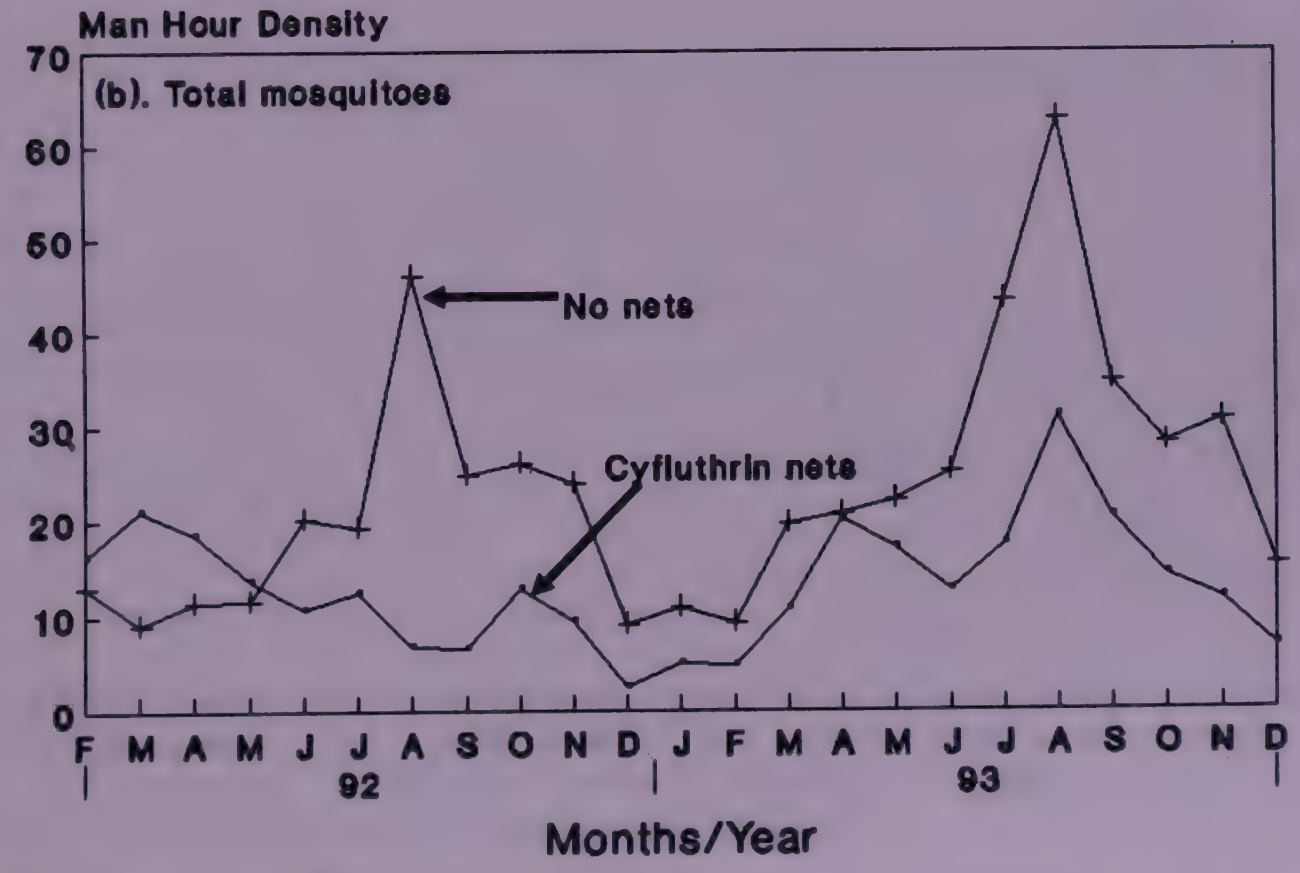
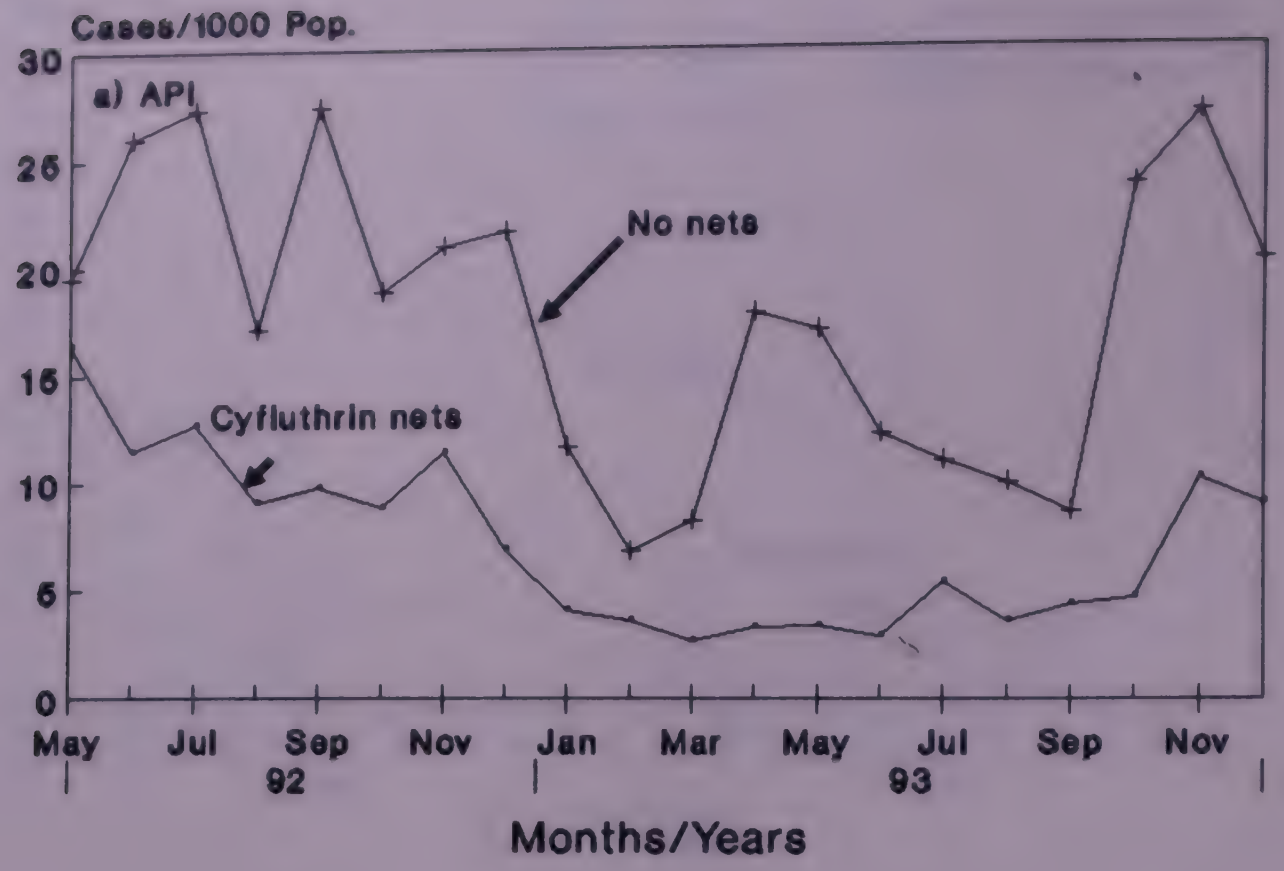


Fig. 3: Rourkela: Indoor density of (a) total anophelines and (b) total mosquitoes in the bednet area and control without nets



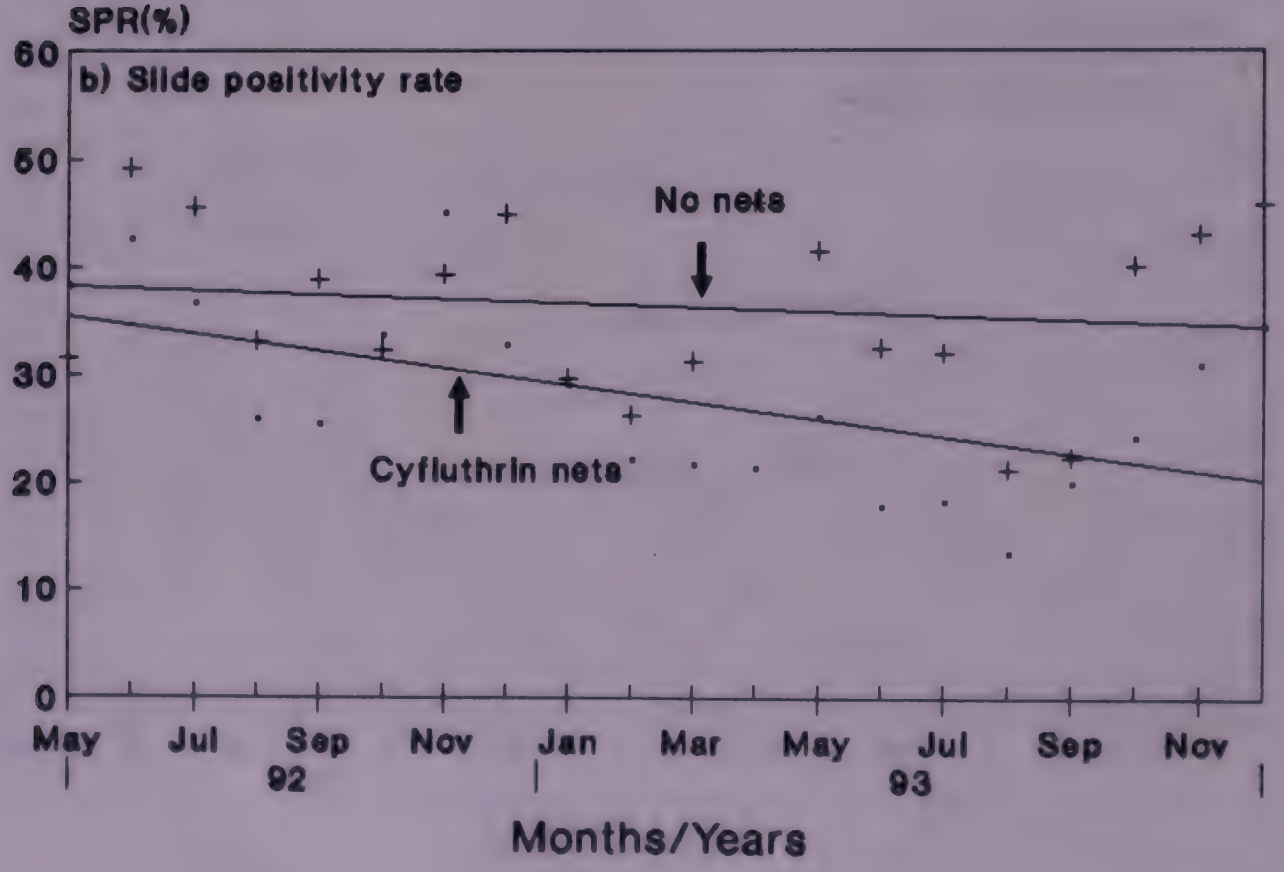


Fig. 4: Rourkela: Impact of bednet intervention on (a) malaria incidence and (b) slide positivity rate in the mines

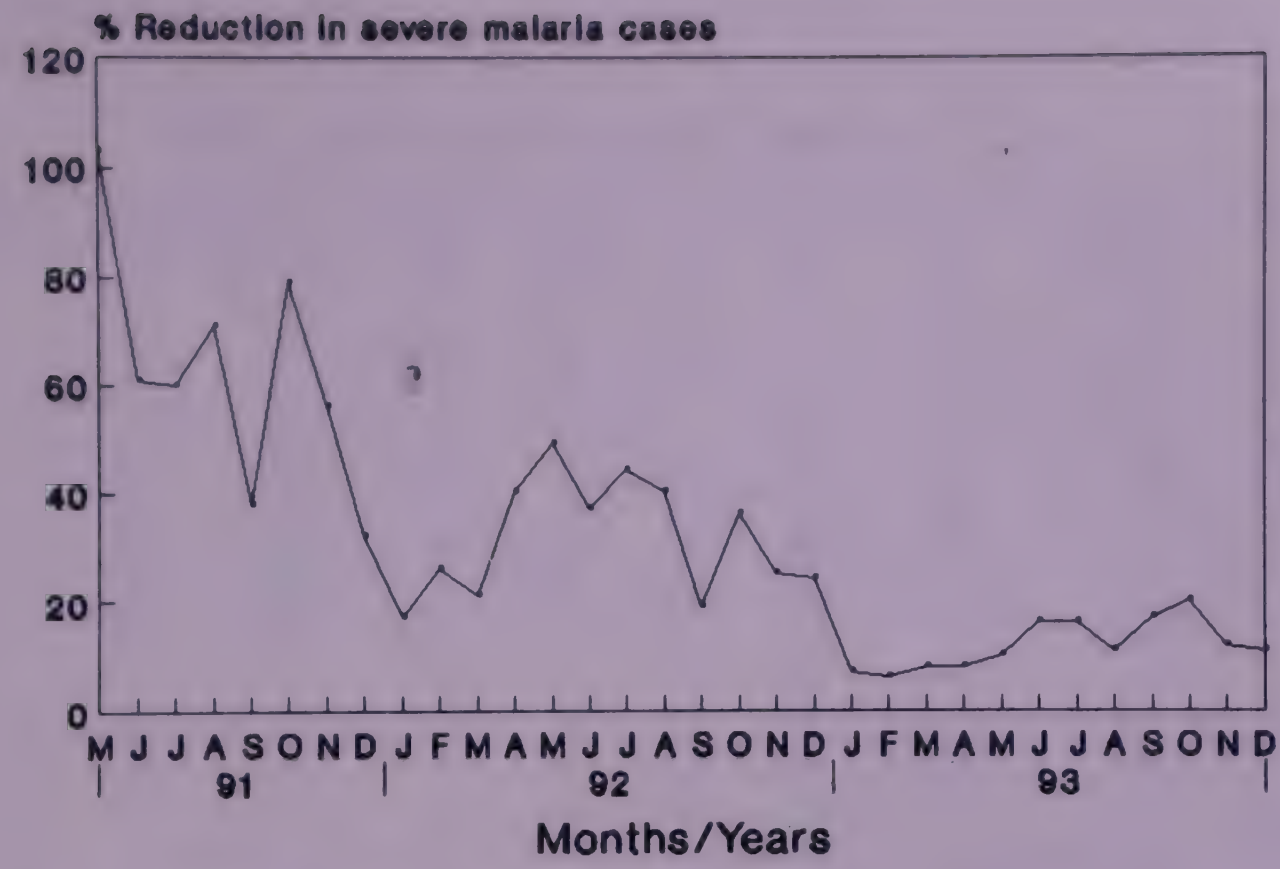


Fig. 5: Rourkela: Impact of bednet intervention on the bed occupancy due to malaria in the mining hospitals

Study on the human genetic polymorphism and its role in malaria: A study on the human genetic polymorphism and its possible role in malaria was started recently in the indigenous pupulation of District Sundergarh. Initially one village of Bisra PHC has been taken for this purpose. To begin with a total of 116 volunteers from Oram (84), Munda tribe (25) and general caste(7) were screened. In the ABO blood grouping system, A(40) and B(39) groups were equally distributed followed by AB (13) and O (24). All the volunteers were Rh positive. Fluorescent spot test was employed for detecting G-6-PD enzyme deficiency. Only 7 cases were G-6-PD deficient, 5 being Oram and 2 Mundas. Sickle cell haemoglobin (Hbs) test was carried out using Dithionite solution, which decreases the solubility of the abnormal haemoglobin at low oxygen tension. Of the 116 cases screened, only 2 showed the presence of sickle cell haemoglobin; one was from general caste while the other from Munda tribe who also showed G-6-PD deficiency. All the blood smears collected in this study negative were for malarial parasites. Further study is in progress.

Malaria Clinic: In the malaria clinic of the field station 3225 fever fever reported for blood examination during 1993. These included cases referred by local clinics and hospitals. Of these 355 (11%) were found malaria positive and 7 microfilariae (W. bancrofti) positive (Table 3). Non-severe malaria cases and microfilarae cases were given treatment, while, severe malaria

TABLE 3: ROURKELA: MALARIA CLINIC DATA (1993)

Months	BSE	Pv	Pf	Pm	Mix	Total	Mf
Jan	169	15	12	0	0	27	0
Feb	142	10	7	0	0	17	1
Mar	163	16	4	0	0	20	1
Apr	150	13	5	0	1	19	2
May	140	10	7	0	0	17	0
Jun	239	22	11	0	0	33	0
Jul	458	18	13	0	0	31	0
Aug	361	11	8	0	0	19	0
Sep	294	14	18	0	0	32	1
Oct	255	10	21	0	2	33	0
Nov	327	14	37	1	0	52	1
Dec	527	11	43	0	1	55	1
Total	3225	164	186	1	4	355	7

TABLE 4: ROURKELA: PERCENTAGE COMPOSITION OF MOSQUITO VECTORS BREEDING IN RICE FIELDS AND ASSOCIATED HABITATS IN BIRKERA (FOREST AREA)

Species	Rice-fields		Ricefield pools		Streams		Ditches	
	a	b	a	b	a	b	a	b
An. culicifacies	1.0		2.1	8.3	36.6	17.7	0.0	
An. fluviatilis	1.6		11.2	2.1	5.0	0.8	0.0	
An. annularis	1.1		4.2	1.4	3.7	1.0	0.0	
Cx. tritaeniorhynchus	19.5	*	17.3	24.1	6.2	6.4	0.0	*
Cx. vishnui	17.6		10.2	0.0	0.6	8.5	0.0	
Cx. quinquefasciatus	0.2		0.1	0.0	0.0	0.2	0.0	
Other anophelines	23.8		31.6	47.5	40.4	51.0	88.7	
Other culicines	35.2		23.3	16.6	7.5	14.4	11.3	
Total no. of mosquitoes emerged	3653		1165	145	161	624	62	

* - Habitats dried, a - Jul to Dec (average of '92 and '93); b - Jan to Jun'93

cases were referred to the Goverment hospital for indoor treatment.

Study on mosquito breeding in riceland agro-ecosystems with particular reference to malaria:

A study on mosquito breeding in different rice agro-ecosystems was started in July, 1992. Rice is the major crop of district Sundergarh which is mainly rainfall dependent, except some areas where irrigation facility is available. For the study four villages were selected, one each in forest area, broken-forest area with irrigation facility, broken-forest area without irrigation and in peri-urban area of Rourkela town.

Larvae and pupae were collected using standard dippers from the rice nurseries, rice fields and other associated breeding habitats viz. pools, streams, channels/canals, wells, pits etc. on weekly basis. Plant height, depth of water in fields, pH turbidity etc. were also monitored weekly. Immature stages of mosquitoes were brought to the laboratory and adult species were recorded on emergence. Indoor mosquito densities were also recorded fortnightly. Surveillance was done on weekly basis by house-to-house visits.

From larval samples drawn from ricefields a total of 34 mosquito species emerged, which included 16 anopheline species, 16 Culex species and two Aedes species.

Data on the vector of diseases which emerged from the larval samples collected from paddy fields and their associated habitats in the forested village (Birkera) are presented in Table 4. It is observed that the rice fields contributed less than 2% of each malaria vector viz. Anopheles culicifacies (1%), An. fluviatilis (1.6%) and An. annularis (1.1%). Culex tritaeniorhynchus accounted for 19.5%, Cx. vishnui 17.6%, while Cx. quinquefasciatus 0.2%. Thus, majority of breeders were culicine species followed by non- vector anophelines. The ricefield pools, that were mostly formed when water from higher fields fall into the lower fields due to terraced rice cultivation, contributed to the malaria vectors substantially as compared to main ricefields. Streams were also preferred by An. fluviatilis, An. annularis and Cx. vishnui group of the population mosquitoes but contributed most of An. culicifacies (36.6% from July to December and 17.7% from January to June).

Data on the mosquito breeding in the rice fields in village Pograbahal in the broken forest area is presented in Table 5. Breeding of An. annularis was 2% in all, while other malaria vectors were very minimal. Cx. vishnui group of mosquitoes accounted for 39%, while Cx. quinquefasciatus was

TABLE 5: ROURKELA: PERCENTAGE COMPOSITION OF MOSQUITO VECTORS BREEDING IN RICEFIELDS AND ASSOCIATED HABITATS IN POGRABAHAL (BROKEN-FOREST AREA)

Species	Rice-field		Ditches field	
	a	b	a	b
An. culicifacies	0.60		0.2	0.0
An. fluviatilis	0.04		0.0	0.0
An. annularis	2.00		1.0	0.0
Cx. tritaeniorhynchus	25.60	*	24.6	9.8
Cx. vishnui	13.10		23.8	1.6
Cx. quinquefasciatus	0.04		1.6	4.3
Other anophelines	33.10		33.7	26.7
Other culicines	25.50		15.1	57.6
Total no. of mosquitoes emerged	2351		509	255

* - Habitats dried; a - Jul to Dec (average of '92 and '93); b - Jan to Jun'93

TABLE 6: ROURKELA: PERCENTAGE COMPOSITION OF MOSQUITO VECTORS BREEDING IN RICEFIELDS AND ASSOCIATED HABITATS IN BALANDA (IRRIGATED AREA)

Species	Nurseries		Rice-fields		Canals/ Channels		Streams		Ditches	
	a	b	a	b	a	b	a	b	a	b
An. culicifacies	1.1	0.8	0.2	1.7	6.1	34.7	6.0	2.0	0.0	11.8
An. fluviatilis	0.0	0.0	0.1	0.0	2.6	0.0	1.9	1.3	0.0	0.0
An. annularis	4.7	4.8	1.6	1.0	13.8	21.0	35.2	48.0	0.0	0.0
Cx. tritaeniorhynchus	26.8	43.4	22.9	20.1	28.5	9.1	1.4	9.2	10.7	0.0
Cx. vishnui	47.6	16.4	27.6	2.4	11.1	6.4	4.2	3.9	2.2	0.0
Cx. quinquefasciatus	1.0	0.5	2.8	0.0	0.0	3.2	0.0	2.0	2.2	0.0
Other anophelines	12.5	16.6	22.5	36.4	23.9	13.1	42.0	15.1	64.1	88.2
Other culicines	6.3	17.5	22.3	38.4	14.0	12.3	9.3	18.5	20.8	0.0
Total no. of mosquitoes emerged	615	373	3297	418	537	219	216	152	178	34

* - Habitats dried; a - Jul to Dec (average of '92 and '93); b - Jan to Jun'93

negligible. The associated ditches also presented a similar picture. Among other habitats breeding in wells and ponds was insignificant hence data are not tabulated.

In the canal irrigated village Balanda (Table 6) cultivation of rice was preceded by setting up rice nurseries. Two crops were grown in that village i.e kharif from July to December and rabi from January to June. In nurseries, breeding of An. culicifacies was about 1% and of An. annularis 4.7%. Cx. vishnui group of mosquitoes accounted for 74.4% during kharif crop and 59.8% during rabi crop. The main ricefield contributed 0.2 % An. culicifacies during kharif and 1.7 % during rabi crop. However, the main canals and the field channels contributed most of An. culicifacies and An. annularis followed by An. fluviatilis. The stream was also preferred by An. annularis due to heavy growth of vegetation followed by An. culicifacies and An. fluviatilis.

In the peri-urban area of Rourkela town, rice was cultivated both during rabi and kharif season. Rabi crop received drainage water for irrigation. An. annularis and Cx. vishnui group of mosquitoes were recorded during both the seasons from nurseries and rice fields (Table 7). An. culicifacies was recorded mostly during rabi season.

The pattern of larval density in relation to the height of rice plants and depth of water in forest ecosystem is

TABLE 7: ROURKELA: PERCENTAGE COMPOSITION OF MOSQUITO VECTORS BREEDING IN RICE FIELDS AND ASSOCIATED HABITATS (PERI-URBAN AREAS)

Species	Nurseries		Rice fields		Drains		Ditches	
	a	b	a	b	a	b	a	b
An. culicifacies	0.0	5.5	0.5	5.0	1.2	0.0	1.3	
An. fluviatilis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
An. annularis	3.1	1.3	4.1	2.4	2.4	1.0	0.7	
Cx. tritaeniorhynchus	20.5	11.2	18.8	37.8	25.7	33.7	11.3	*
Cx. vishnui	37.4	20.8	17.1	17.1	9.2	24.0	14.9	
Cx. quinquefasciatus	0.5	2.4	1.2	0.2	4.3	3.8	1.1	
Other anophelines	35.9	28.1	34.5	23.7	31.2	13.5	51.4	
Other culicines	2.6	30.7	23.8	13.8	26.0	24.0	19.3	
Total no. of mosquitoes emerged	195	1437	3058	909	327	104	451	

* - Habitats dried; a - Jul to Dec (average of '92 and '93); b - Jan to Jun'93

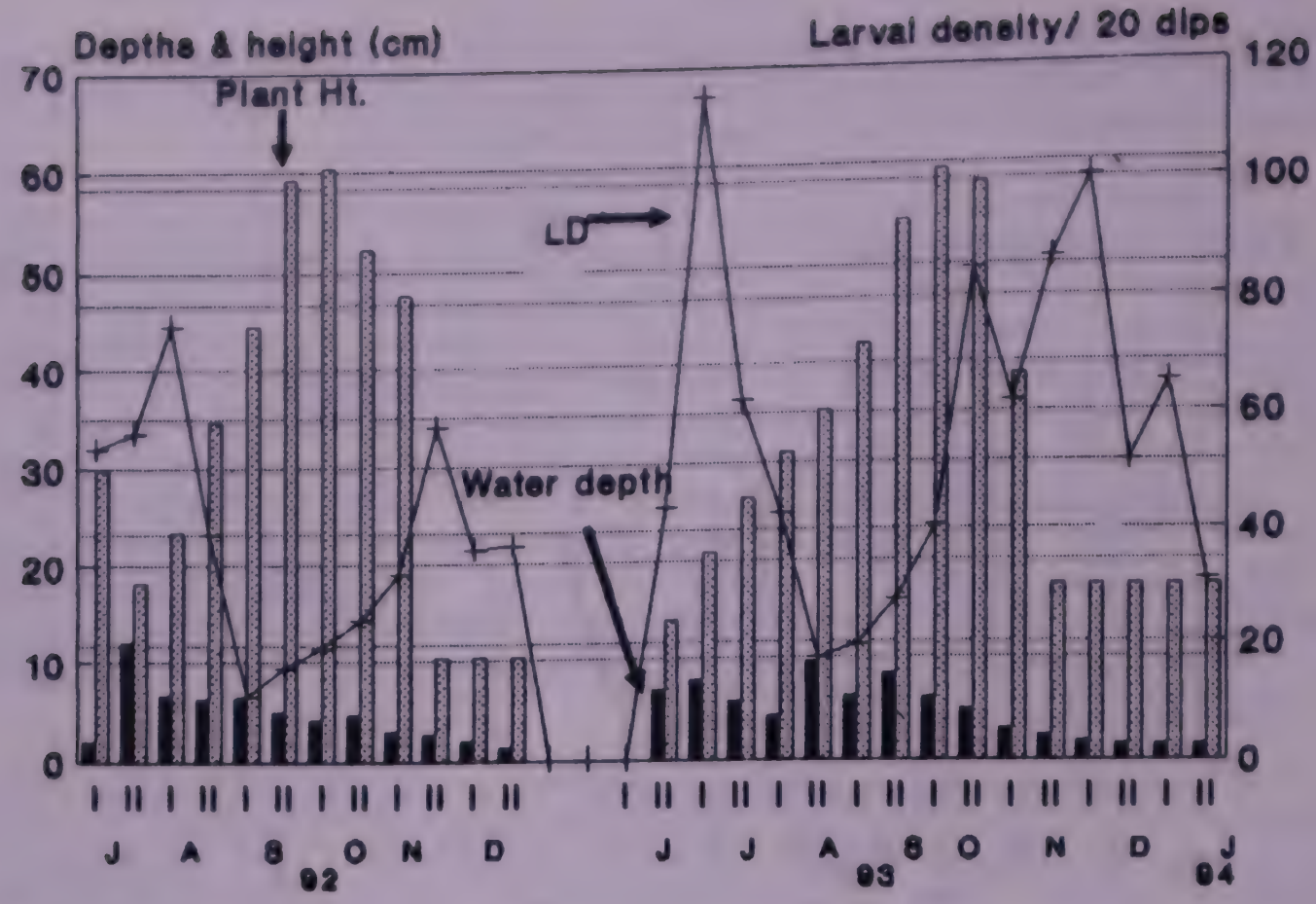


Fig. 6: Rourkela: Pattern of larval density in relation to the growth of rice plants and changes in the depth of water in a village in forest ecosystem

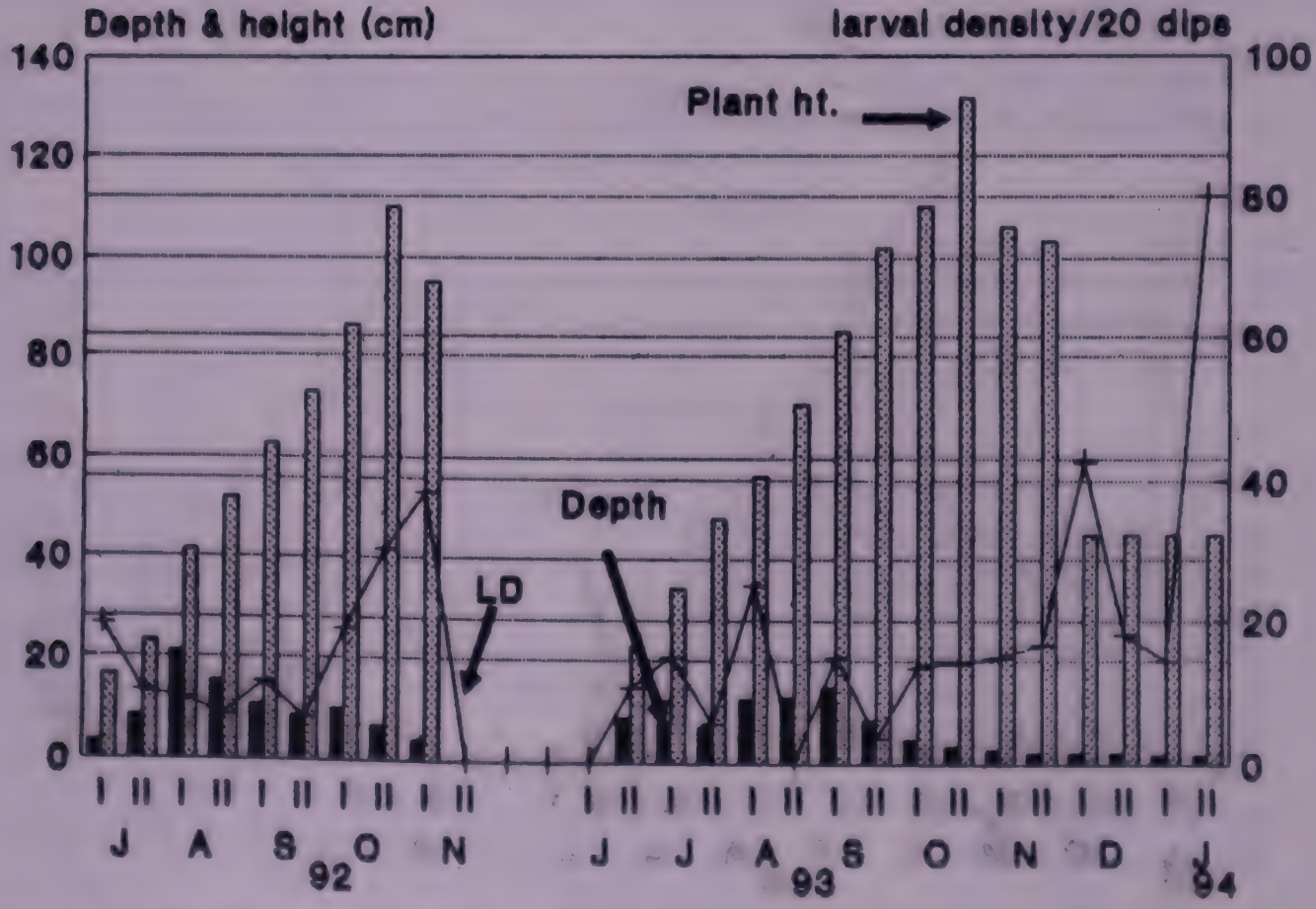


Fig. 7: Rourkela: Pattern of larval density in relation to the growth of rice plants and changes in the depth of water in a village in broken-forest without irrigation

presented in Fig. 6. With the onset of rains in June the larval density increased very high and was mainly accounted by Cx. vishnui group of mosquitoes, non-vector culicines and malaria vectors An. culicifacies and An. fluviatilis. Later the density declined with the growth of plants but from September onwards it picked up due to the breeding of An. nigerrimus, An. pallidus, non-vector culicines and Cx. vishnui group of mosquitoes. Later with the harvest of the crop when stumps were left in the field the larval density declined.

Ecological succession of mosquitoes in broken-forest village is shown in Fig. 7. In the beginning the increase in larval density was due to An. subpictus and An. vagus and when they declined Cx. vishnui group and non vector culicines increased in density. From September onwards greater increase in density was due to An. nigerrimus and An. pallidus. Breeding of An. culicifacies was recorded in the months of August in 1992 and July in 1993 i.e. the beginning of the crop. Thus, with the growth of the plant and possibly other factors this species was replaced by other species.

Larval density in the peri-urban area of Rourkela is presented in Fig. 8. Cx. vishnui group of mosquitoes bred extensively before rice cropping in August. From September onwards breeding of An. nigerrimus, An. pallidus and other culicines also increased. During the Rabi crop the initial high larval density was due to An. subpictus, An. vagus, Cx. vishnui group of mosquitoes and other culicines. During February-March there was a general decline but these species once again increased in April. An. culicifacies was recorded from January to March with low composition.

Succession of larval density in irrigated village (Balanda) is presented in Fig. 9. Kharif crop was grown from August onwards. Before that there was extensive breeding of Cx. vishnui group of mosquitoes and other culicines in the flooded fields. With the growth of rice plants there was a decline in density but from September onwards due to the breeding of An.nigerrimus, An. pallidus and Cx. vishnui there was a sharp increase in larval density. In the second week of October farmers dried their fields pending harvesting, therefore, breeding vanished completely. During the rabi crop that followed there was a gradual increase in density from January to March due to the breeding of An. subpictus, An. vagus, Cx. vishnui group of mosquitoes and other culcines. Later the density declined by May.

The study so far conducted shown that the main ricefields contributed poorly to malaria vectors slight contribution observed was in the beginning of the crop or in the fallow fields, but contributed most of Cx. vishnui group of mosquitoes, vector of JE. Breeding of Cx. quinquefasciatus, vector of filariasis was very scanty in ricefields. Among

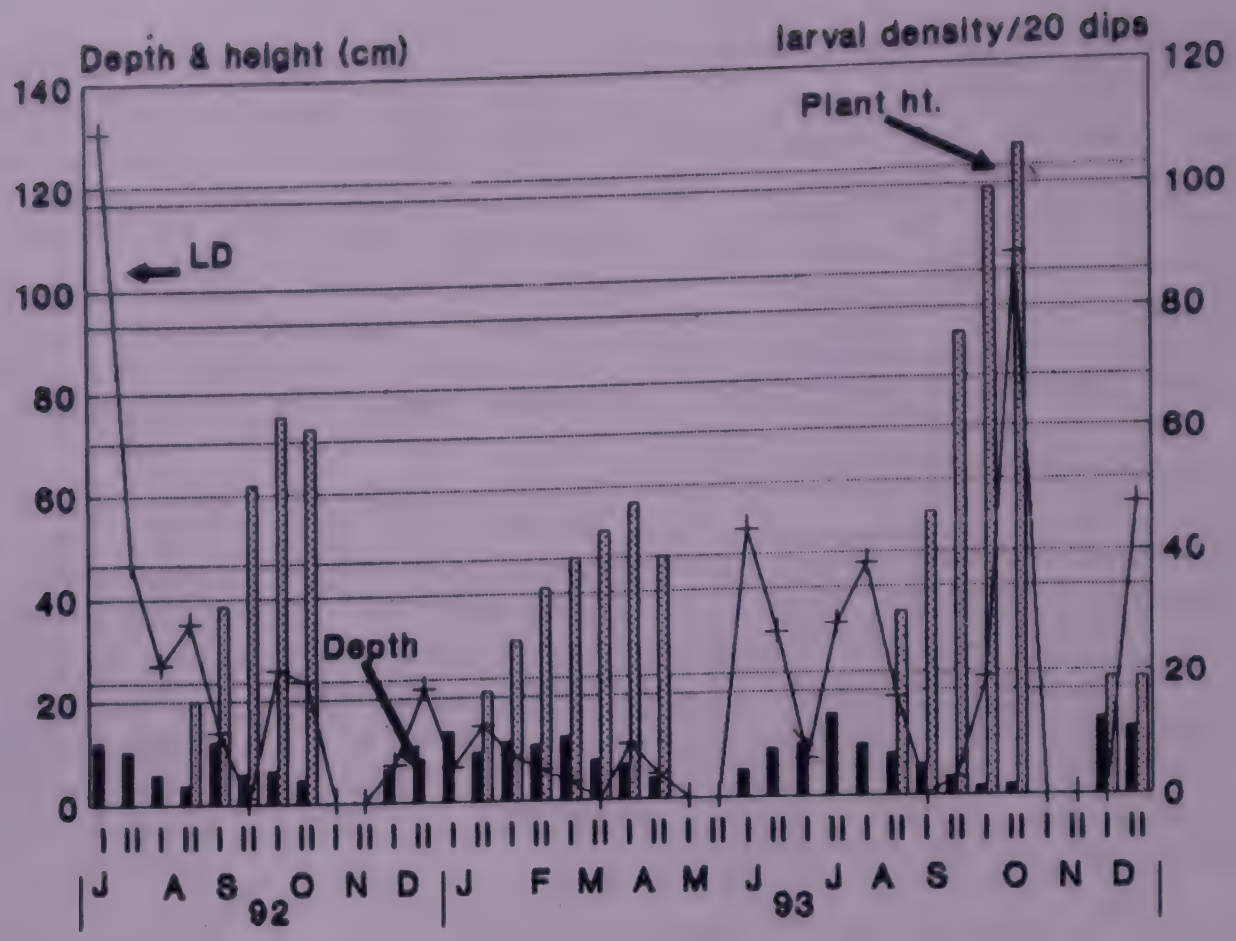


Fig. 8: Rourkela: Pattern of larval density in relation to the growth of rice plants and changes in the depth of water in peri-urban areas

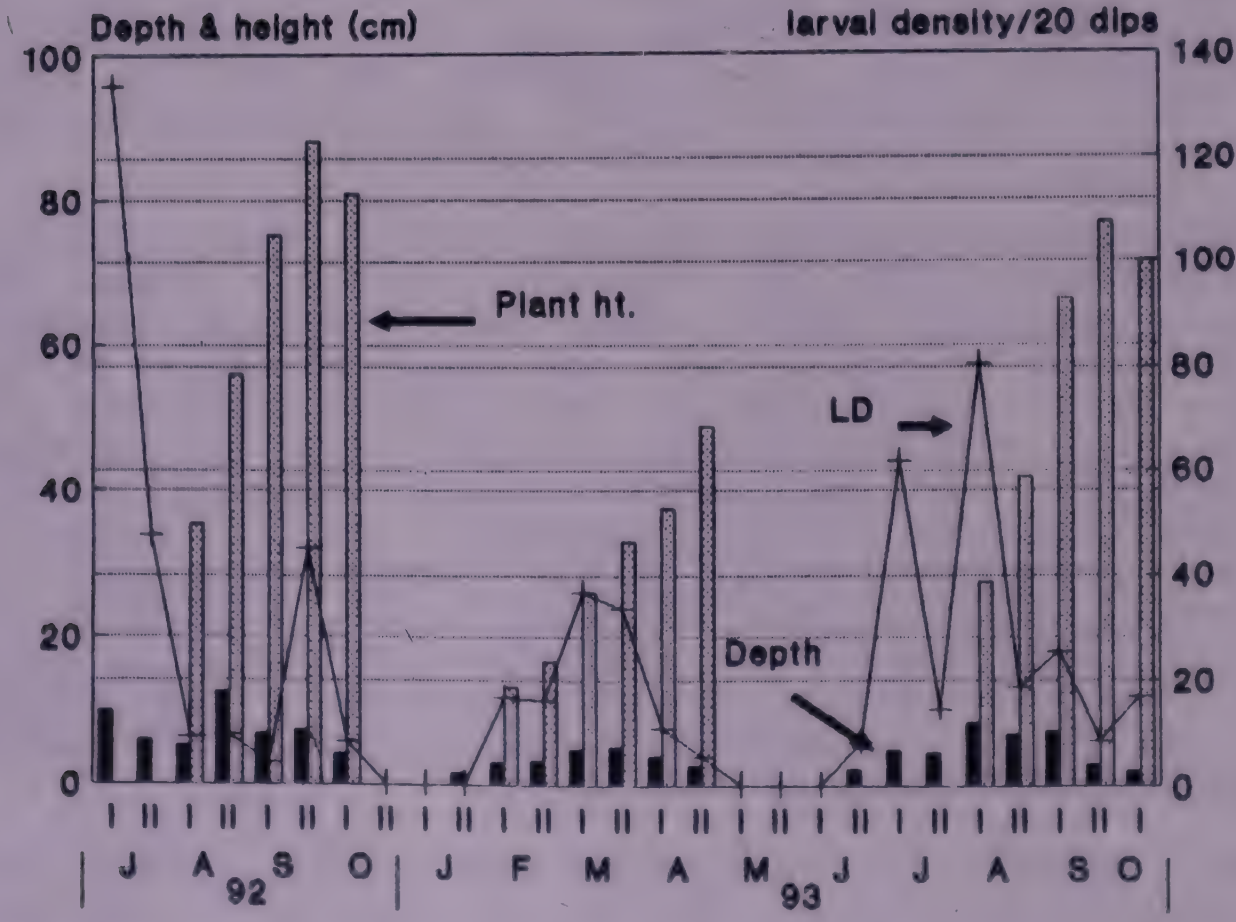


Fig. 9: Rourkela: Pattern of larval density in relation to the growth of rice plants and changes in the depth of water in a village in broken-forest with irrigation

associated habitats streams, ricefield pools and channels/canals were the real supporters of breeding of vectors of malaria. The study is in progress and on completion would be applied in formulation of a vector control strategy.

Evaluation of Biolarvicides for Mosquito Control in Rourkela Township

An operational trial was conducted in Rourkela town in collaboration with the municipality to evaluate anti-larval efficacy of biolarvicides Spherix (Bacillus sphaericus) and Bactoculicide (Bacillus thuringiensis israelensis). Two separate localities with a total population of 23,000 were taken for evaluation of the efficacy of Spherix, while one locality (pop. 5000) was taken for evaluation of Bactoculicide. Spherix was sprayed @ 1gm/sq m in the beginning of June'93, while Bactoculicide was sprayed at @ 0.5 gm/ sq m from August'93. Aqueous mixture (w/v) of biolarvicide powder was sprayed using knapsac sprayers so as to obtain required dosages in mosquito breeding habitats. A concurrent area where the municipality continued anti-larval measures under Urban Malaria Scheme using malariol oil etc., was taken for comparison. Larval densities were monitored on weekly basis and habitats were resprayed on appearance of 3rd/4th instars. Densities of indoor resting mosquitoes were also monitored by aspirator collection on fortnightly basis.

Efficacy of Spherix: Impact of Spherix was very promising as it checked the mosquito breeding in different habitats sprayed viz. minor and major drains, waste water pools, cement tanks, domestic septic tanks, ricefields in peripheral area etc. In drains which supported heavy breeding of Culex quinquefasciatus and Armigeres, the breeding was checked effectively after Spherix application (Fig. 10). The drains were re-sprayed at an average interval of 7-11 weeks depending on flow of water. Good impact was recorded in waste water pools (Fig. 11). Due to lack of sewarage system in most of the township are as under the study each house has a domestic septic tank. There are a few community septic tanks also. As would be seen from Figs. 12 and 13, Spherix maintained very effective check on Culex breeding, but in certain septic tanks which had Armigeres breeding (Fig. 14), very frequent applications of Spherix were required as the impact was poor.

Several cement tanks abandoned at the construction sites and with algal growth had both anopheline and culicine breeding. Spherix application in these tanks resulted in good control of larvae (Fig. 15) and re-spraying was required after 3 to 19 weeks.

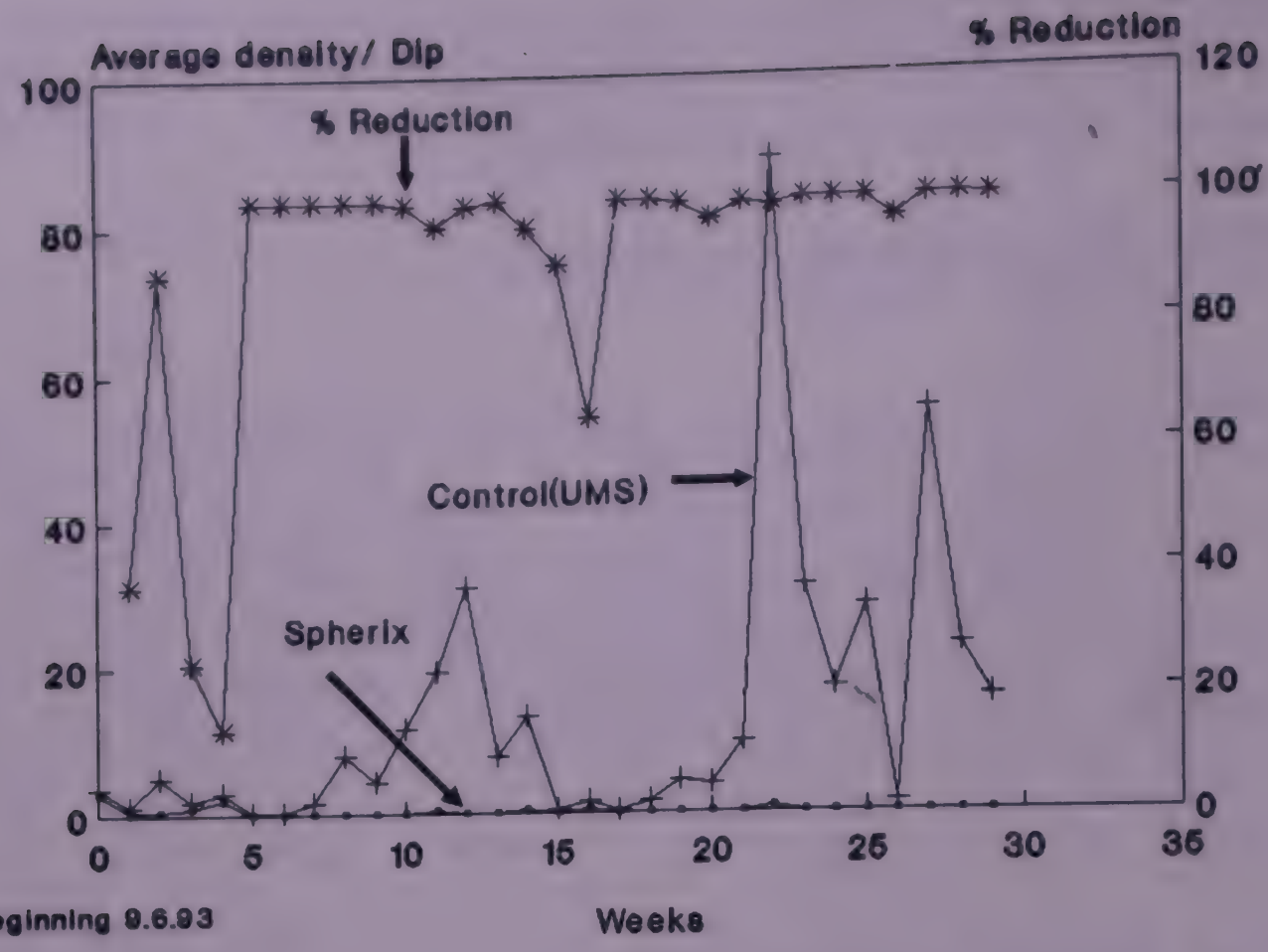


Fig. 10: Rourkela: Impact of spraying Spherix @ 1gm/sq m on mosquito breeding in drains

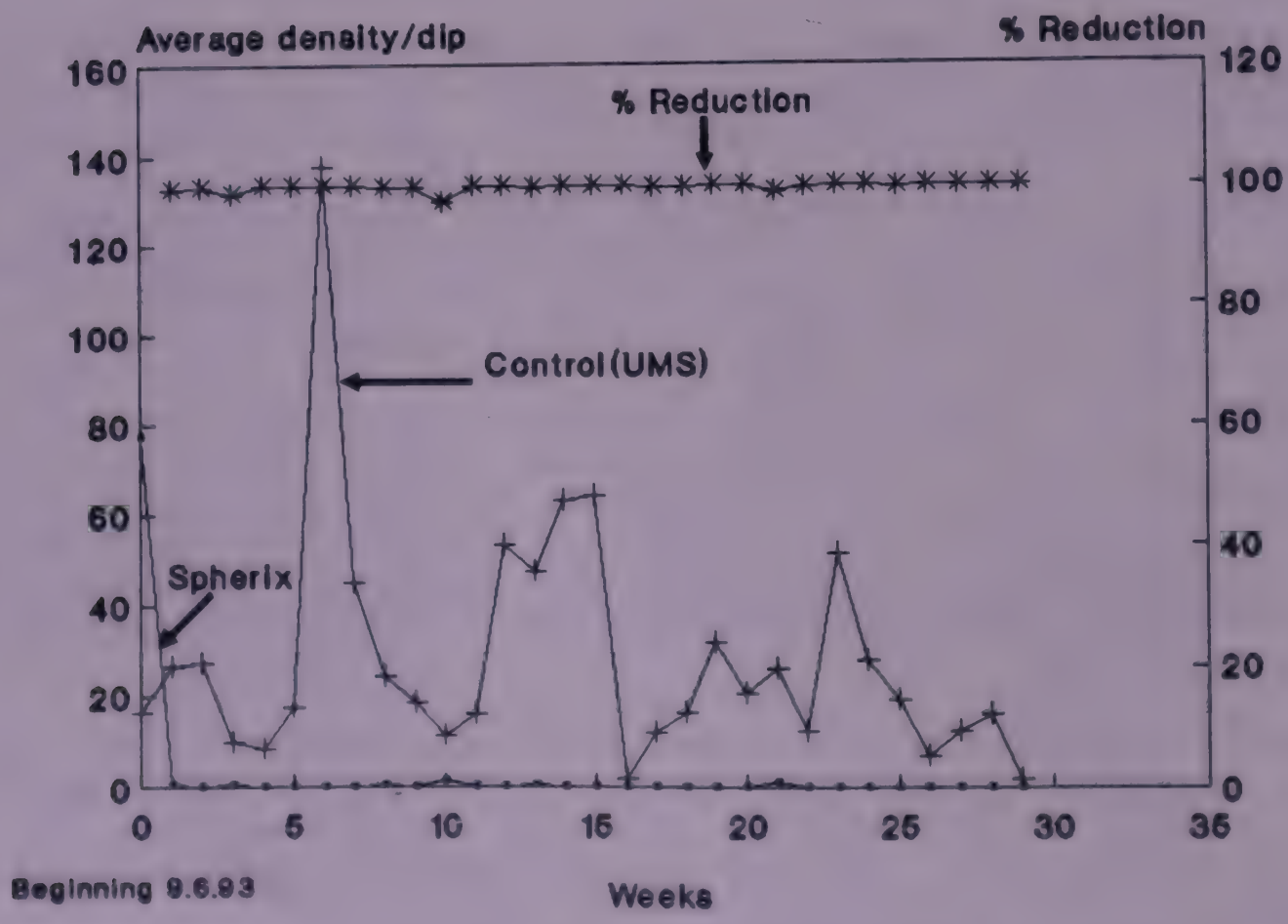


Fig. 11: Rourkela: Impact of spraying Spherix @ 1 gm/sq m on mosquito breeding in waste water pools

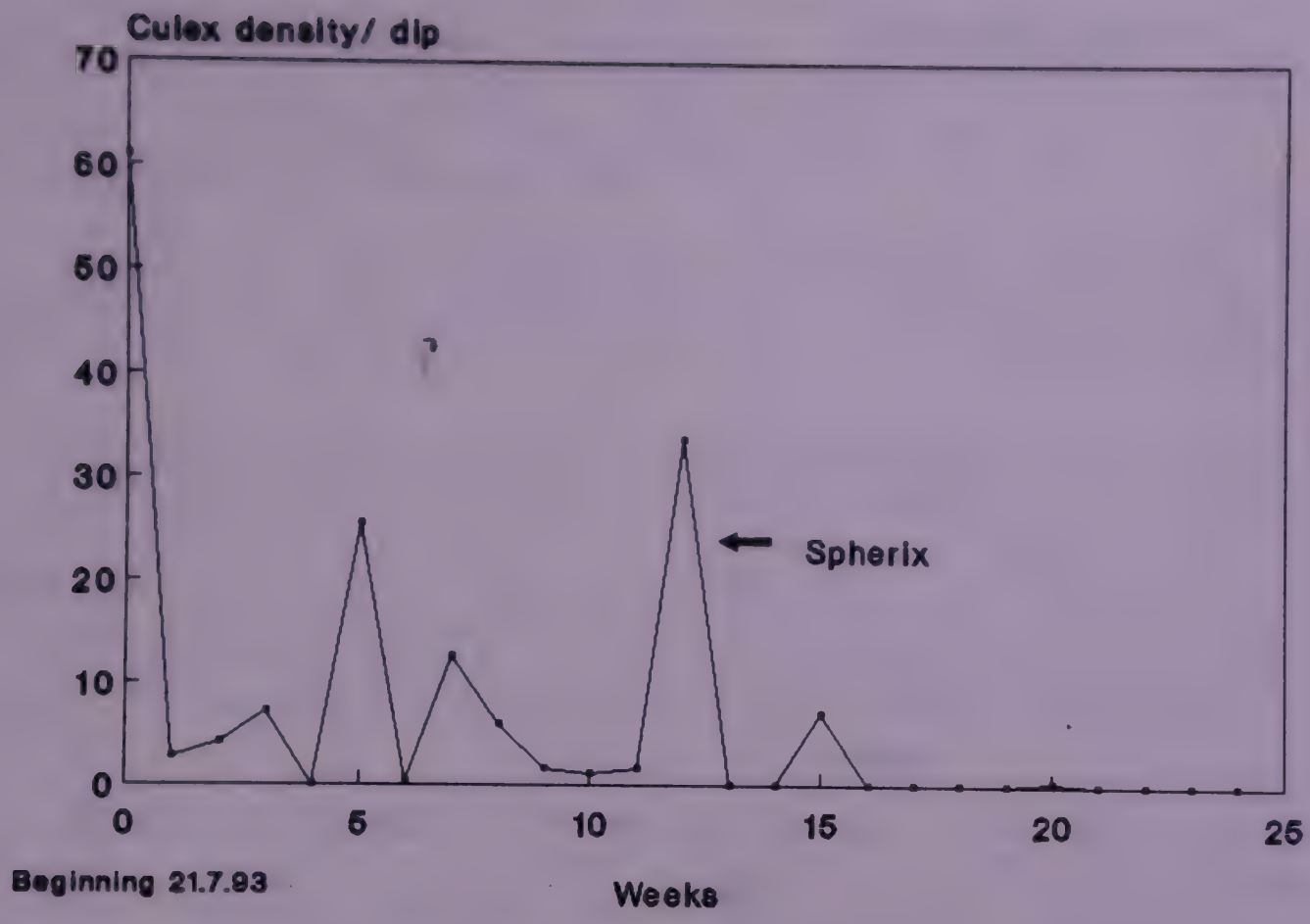


Fig. 12: Rourkela: Impact of spraying Spherix @ 1gm/sq m on the breeding of Culex in domestic septic tanks

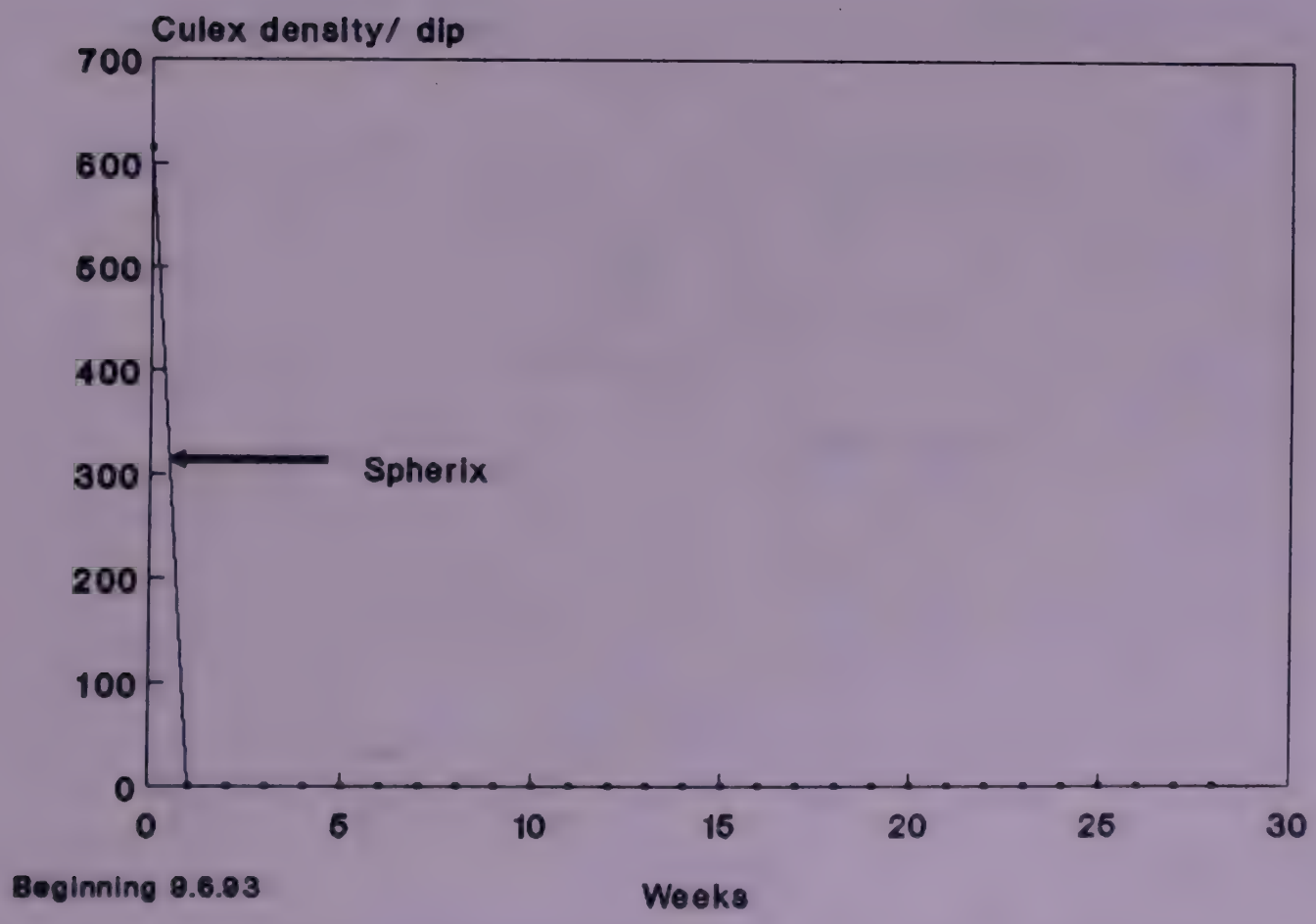


Fig. 13: Rourkela: Impact of spraying Spherix @ 1gm/ sq m on mosquito breeding in community septic tanks

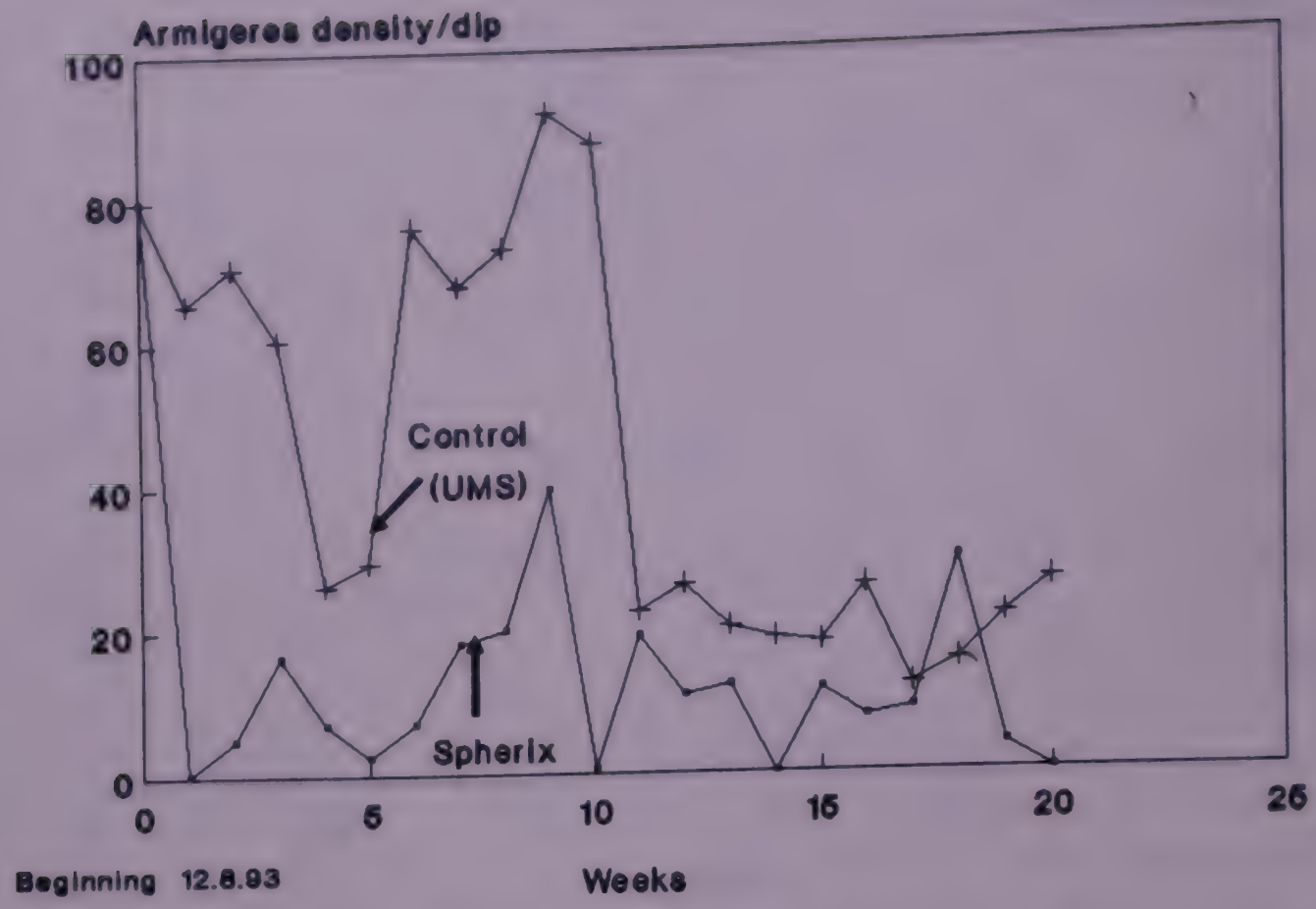


Fig. 14: Rourkela: Impact of spraying Spherix @ 1 gm/sq m on the breeding of Armigeres in domestic septic tanks

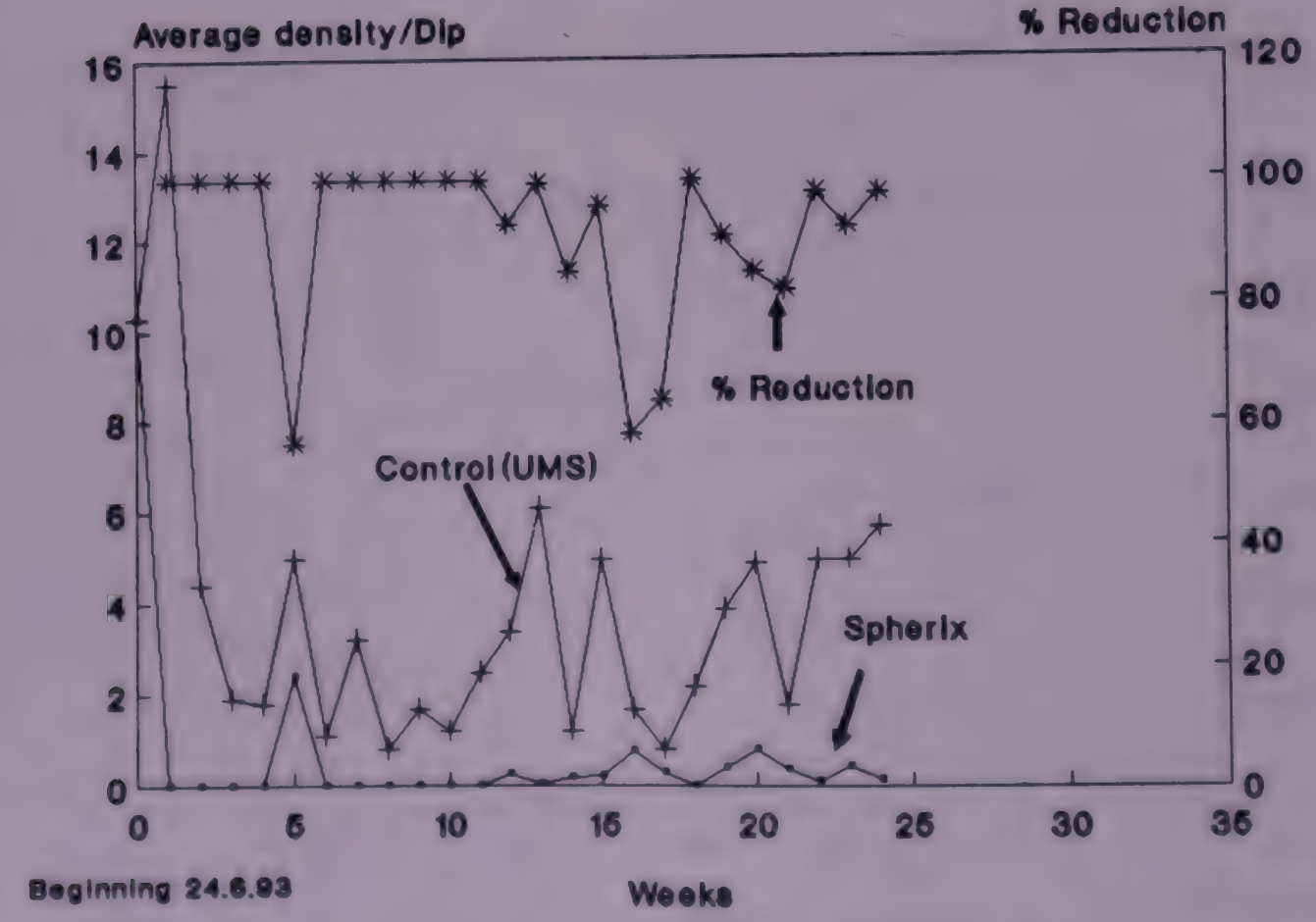


Fig. 15: Rourkela: Impact of spraying Spherix @ 1 gm/sq m on mosquito breeding in cement tanks

In the adjoining peri-urban area few paddy fields which had the breeding of Cx.tritaeniorhynchus , Cx. vishnui, besides anophelines were also sprayed. These fields received drainage water besides the rains. There was a considerable check on breeding after Spherix was sprayed (Fig. 16).

As a result of good larvicidal efficacy of Spherix, there was a reduction in the density of adult mosquitoes in general and (Fig. 17), anophelines (Fig. 18) and Culex in specific (Fig. 19).

Efficacy of Bactoculicide : Bactoculicide was sprayed in another locality and caused equally good impact in controlling mosquito breeding in drains (Fig. 20), the waste water pools (Fig. 21), paddy fields (Fig. 22), cement tanks (Fig. 23) and leaking sluice valve chambers (Fig. 24). After Bactoculicide spray density of all mosquitoes (Fig. 25), anophelines (Fig. 26) and Culex (Fig. 27) declined as compared with the densities in the control area.

The mean biolarvicide re-application intervals varied for different habitat i.e. from 2 weeks to 2 months. Both the biolarvicides caused notable reduction in mosquito densities compared with anti-larval measures and there is now sufficient data to indicate that these larvicides have good promise for

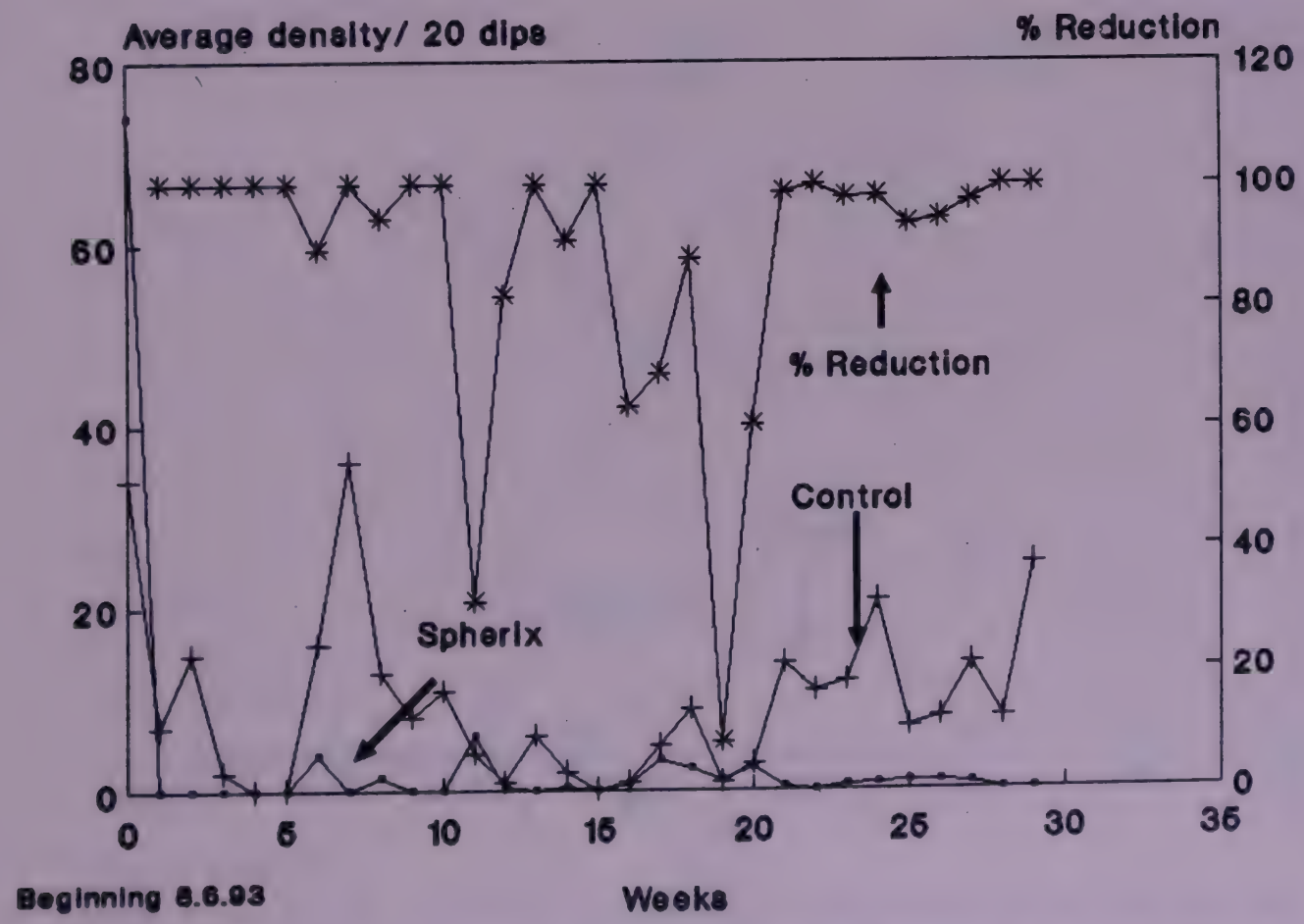


Fig. 16: Rourkela: Impact of spraying Spherix @ 1 gm/sq m on mosquito breeding in rice fields

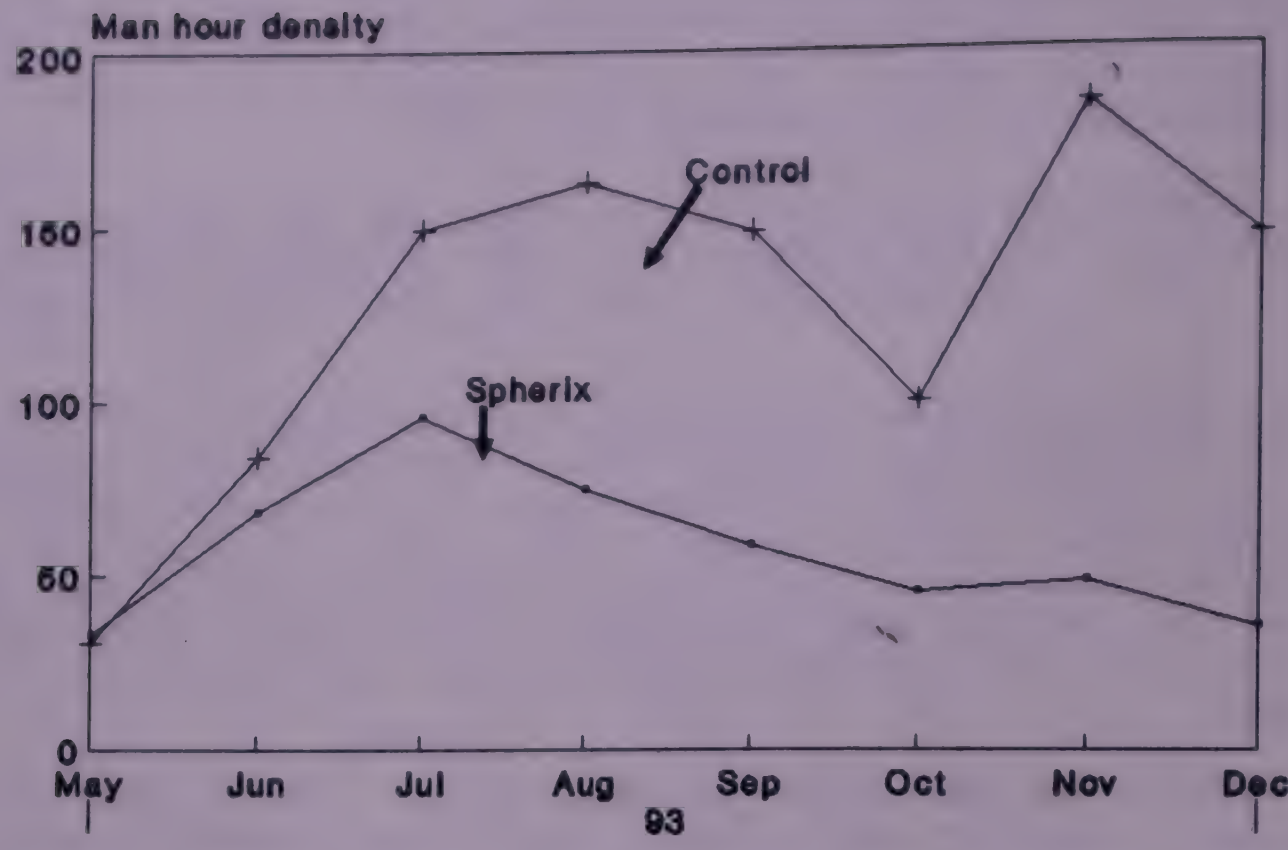


Fig. 17: Rourkela: Impact of spraying Spherix on the indoor density of total mosquitoes

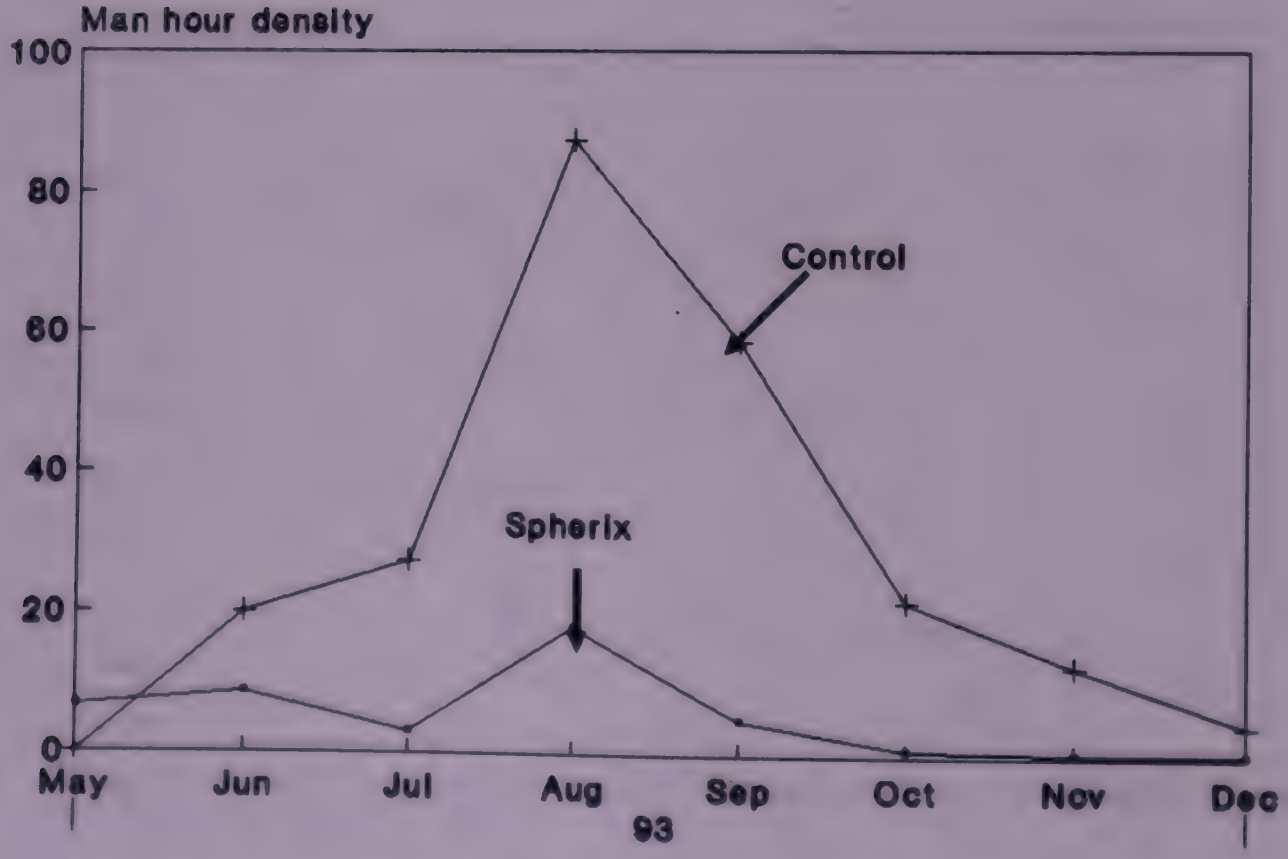


Fig. 18: Rourkela: Impact of spraying Spherix on the indoor density of total anopheline mosquitoes

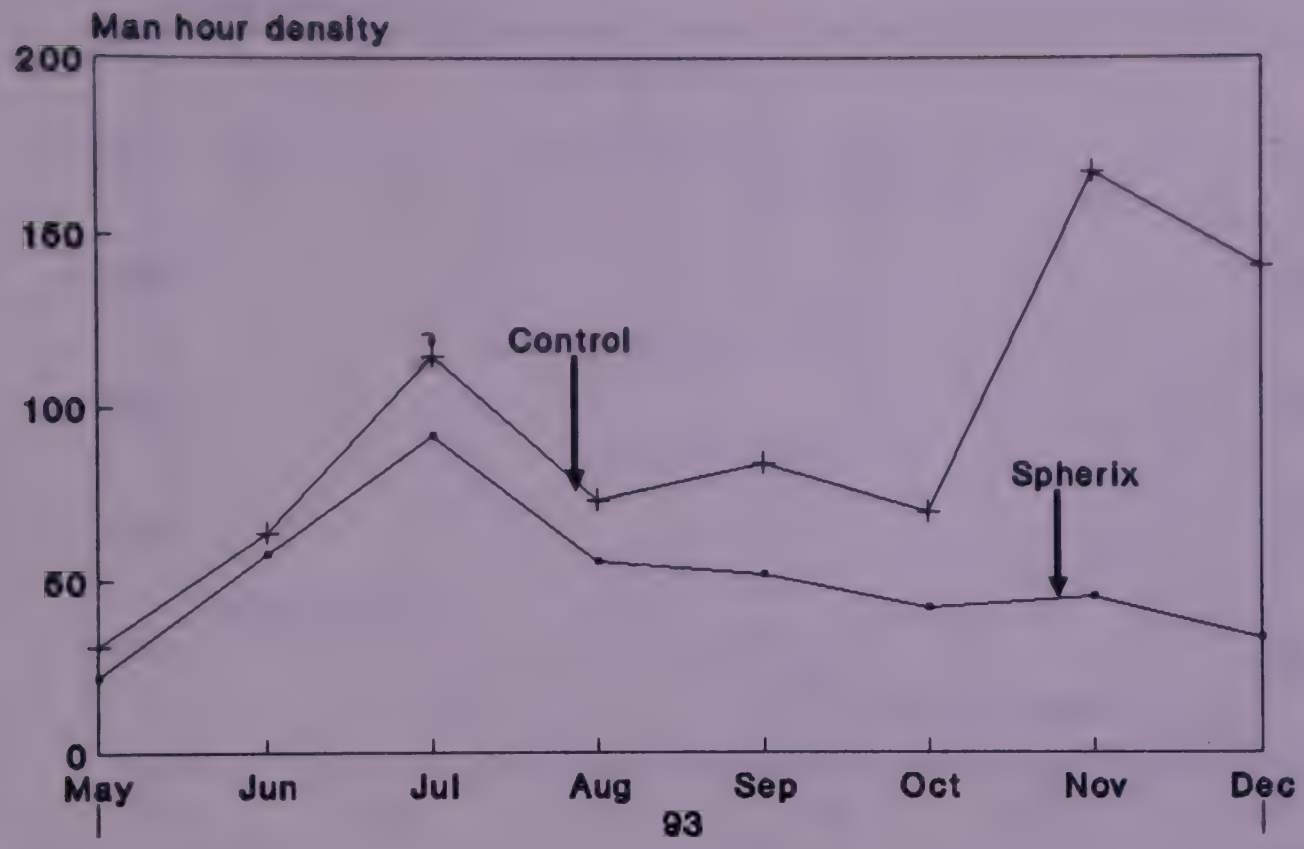


Fig. 19: Rourkela: Impact of spraying Spherix on the indoor density of Cx. quinquefasciatus

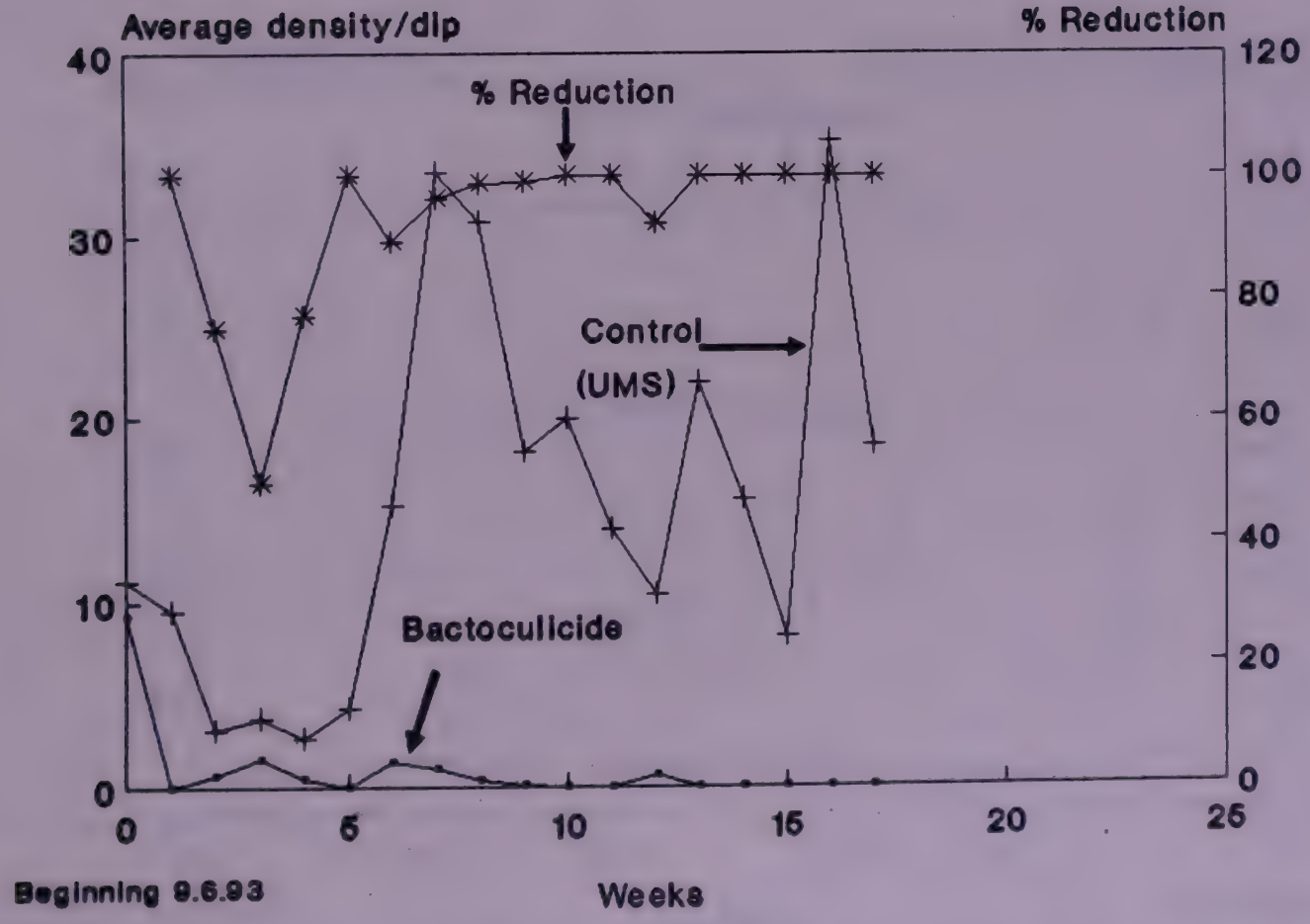


Fig. 20: Rourkela: Impact of spraying Bactoculicide @ 0.5 gm/sq m on mosquito breeding in drains

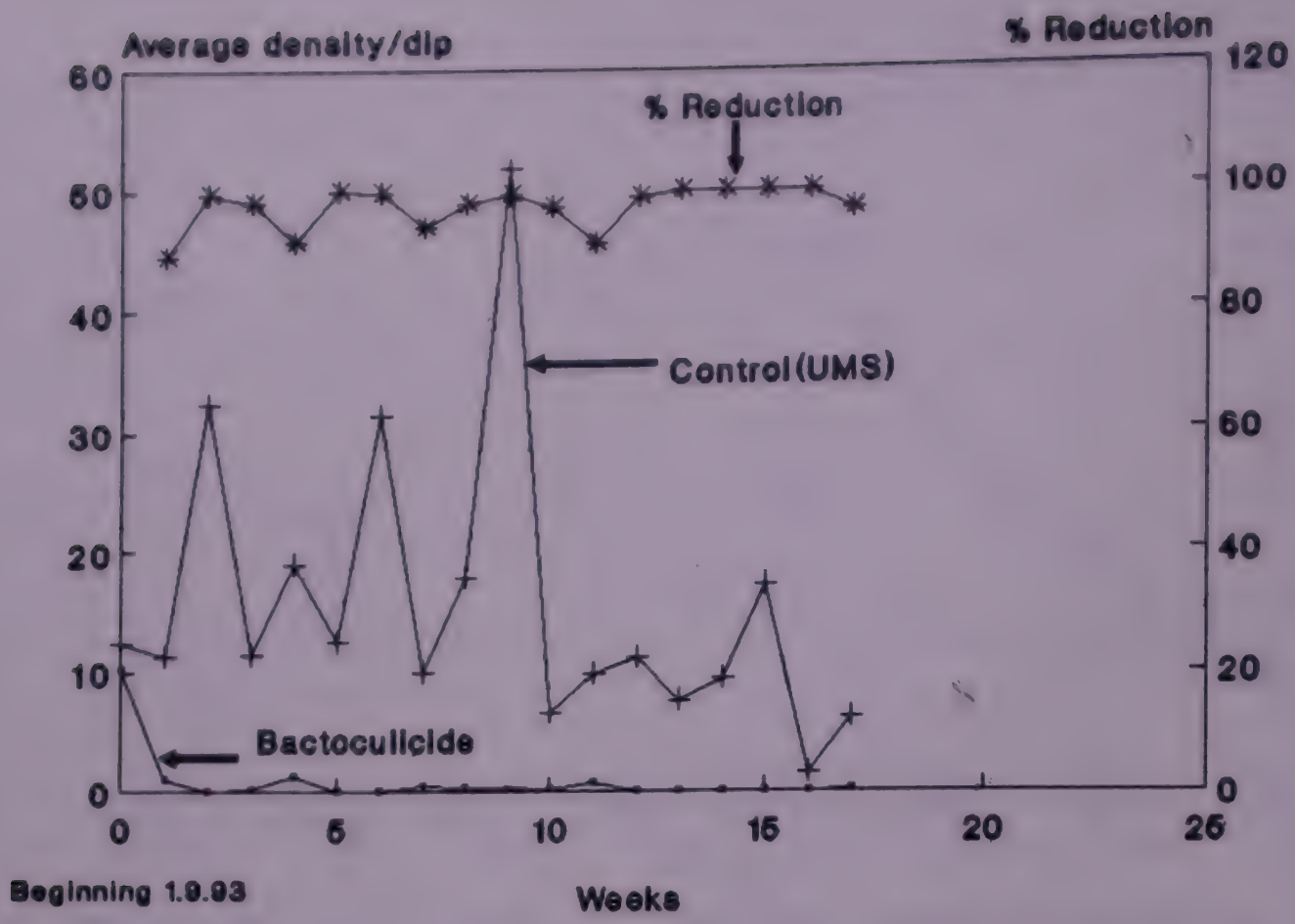


Fig. 21: Rourkela: Impact of spraying Bactoculicide @ 0.5 gm/sq m on mosquito breeding in waste water pools

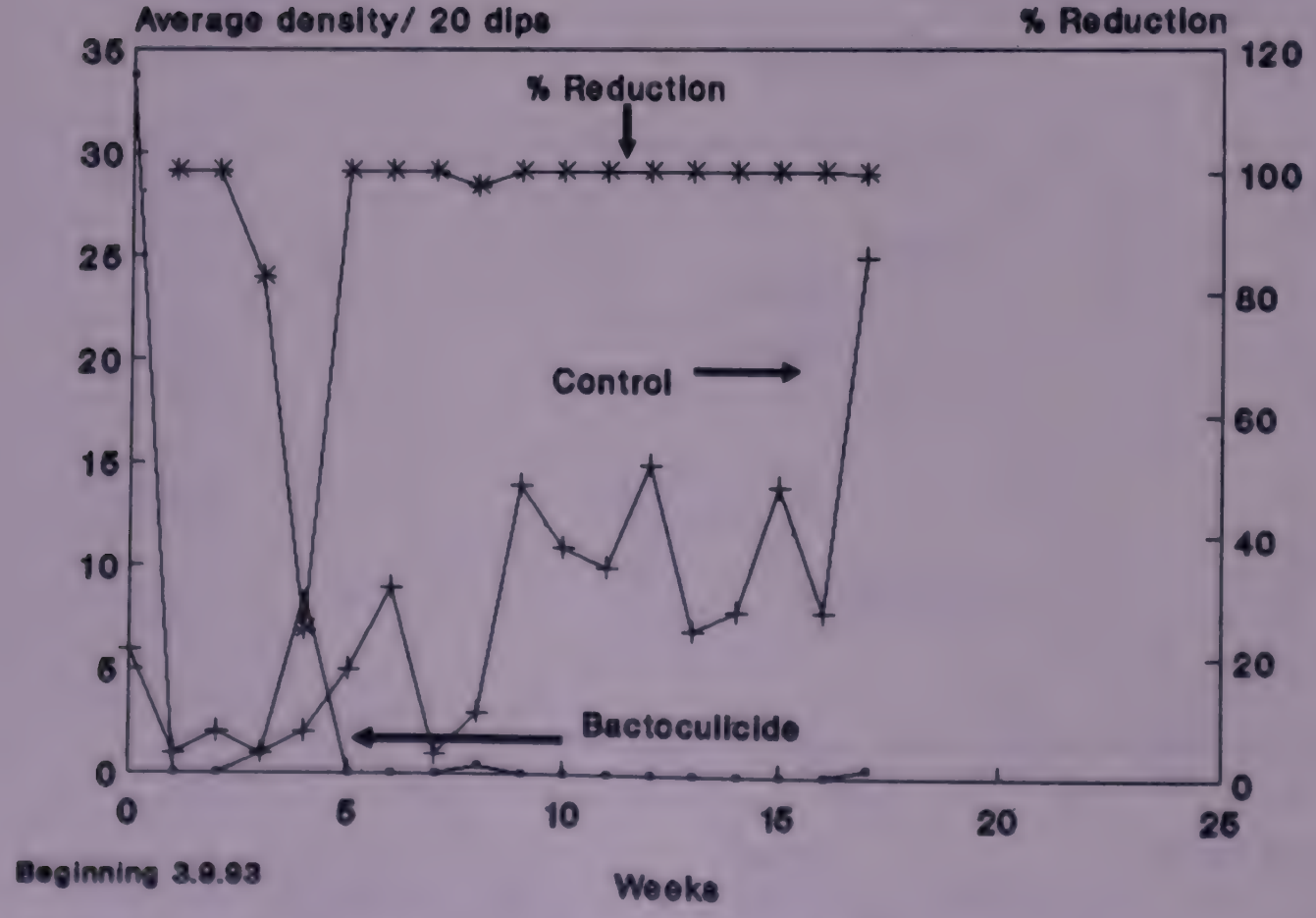


Fig. 22: Rourkela: Impact of spraying Bactoculicide @ 0.5 gm/sq m on mosquito breeding in rice fields

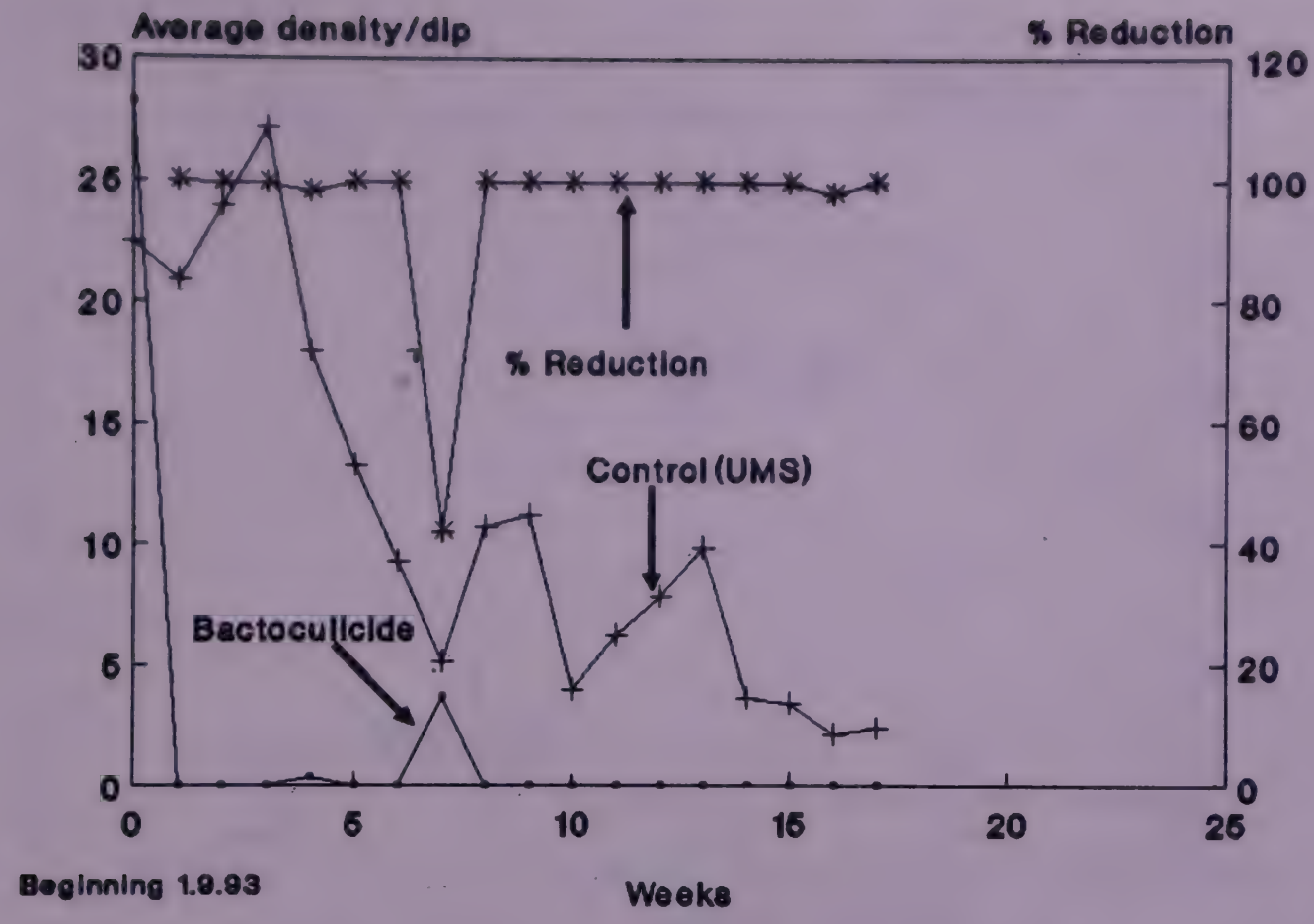


Fig. 23: Rourkela: Impact of spraying Bactoculicide @ 0.5 gm/sq m on mosquito breeding in cement tanks

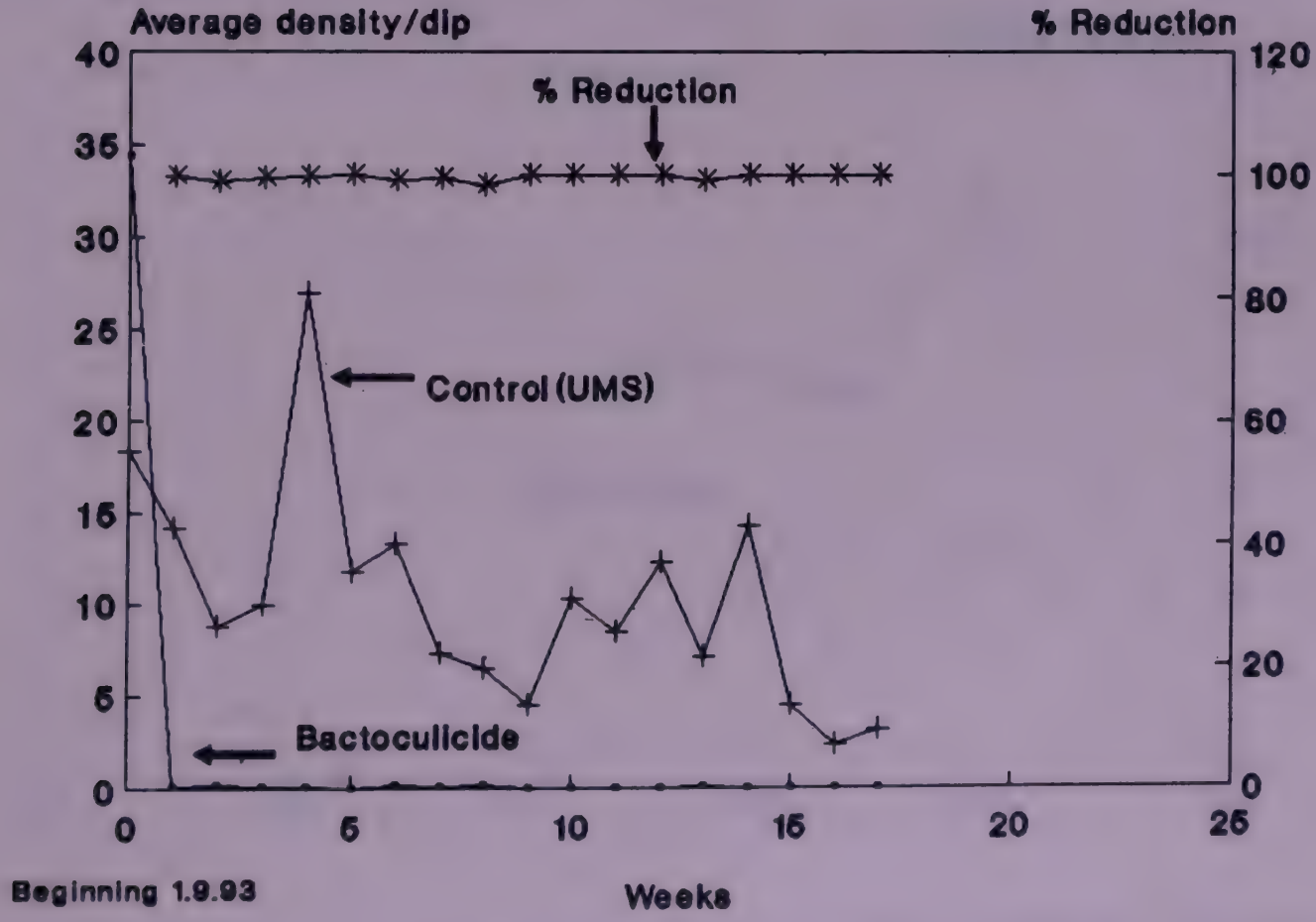


Fig. 24: Rourkela: Impact of spraying Bactoculicide @ 0.5 gm/sq m on mosquito breeding in sluice valve chambers

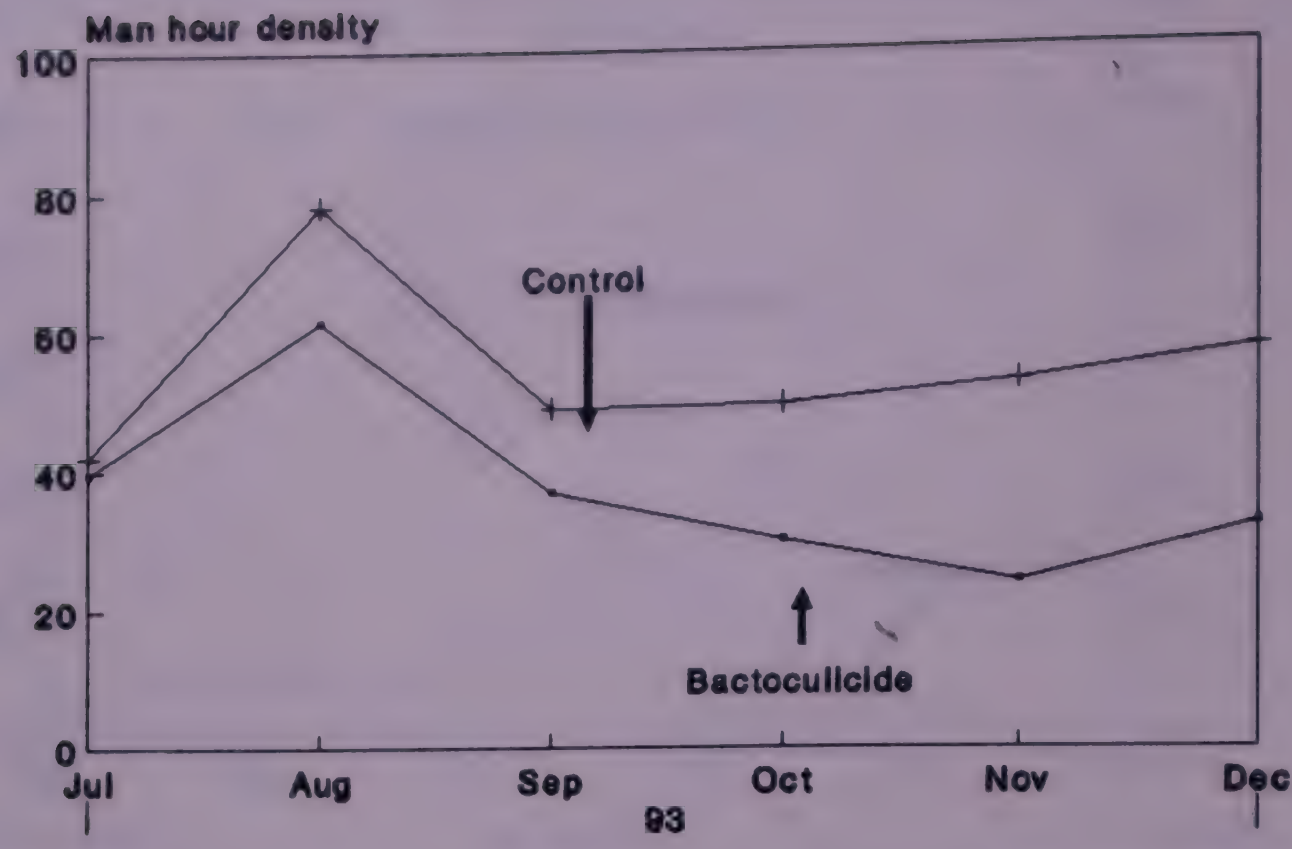


Fig. 25: Rourkela: Impact of spraying Bactoculicide on the indoor density of total mosquitoes

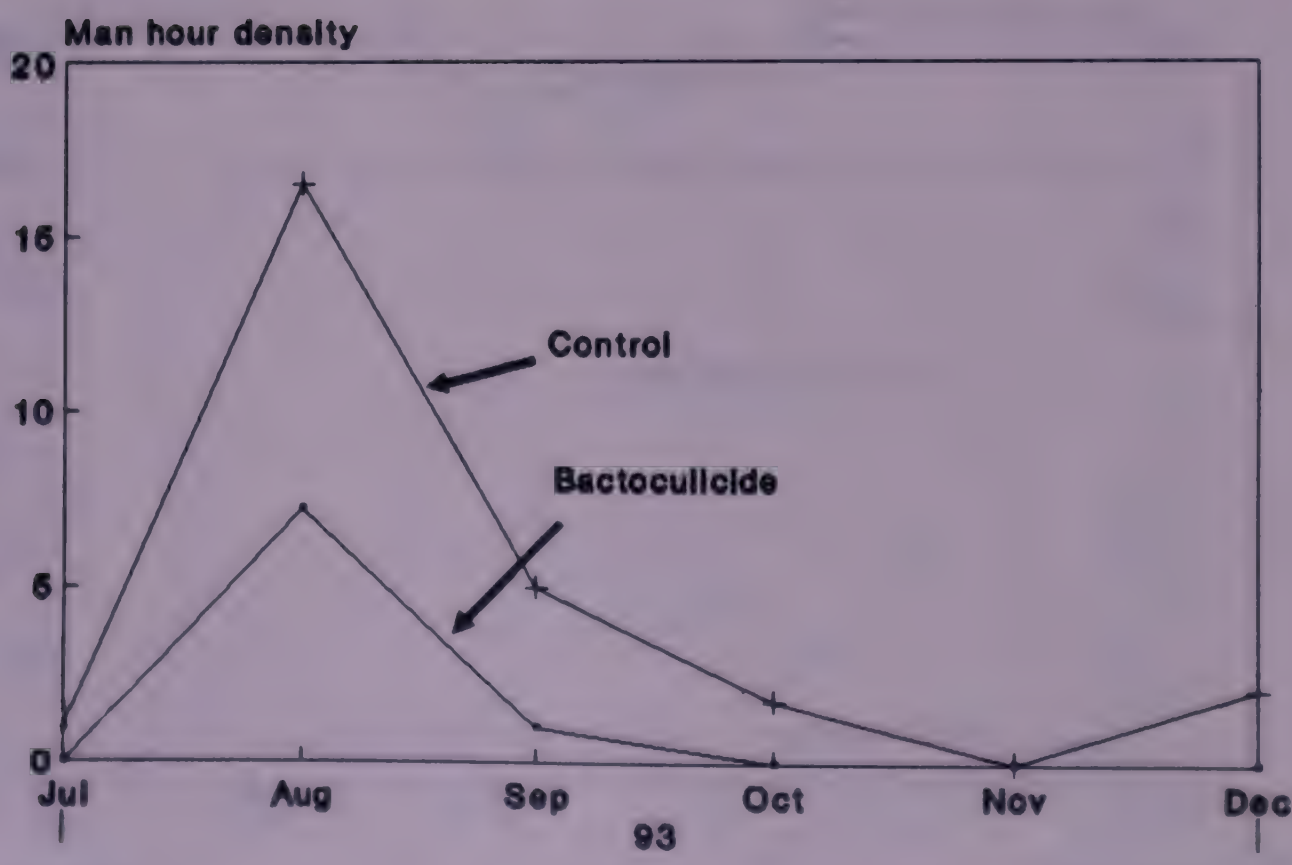


Fig. 26: Rourkela: Impact of spraying Bactoculicide on the indoor density of total anopheline mosquitoes

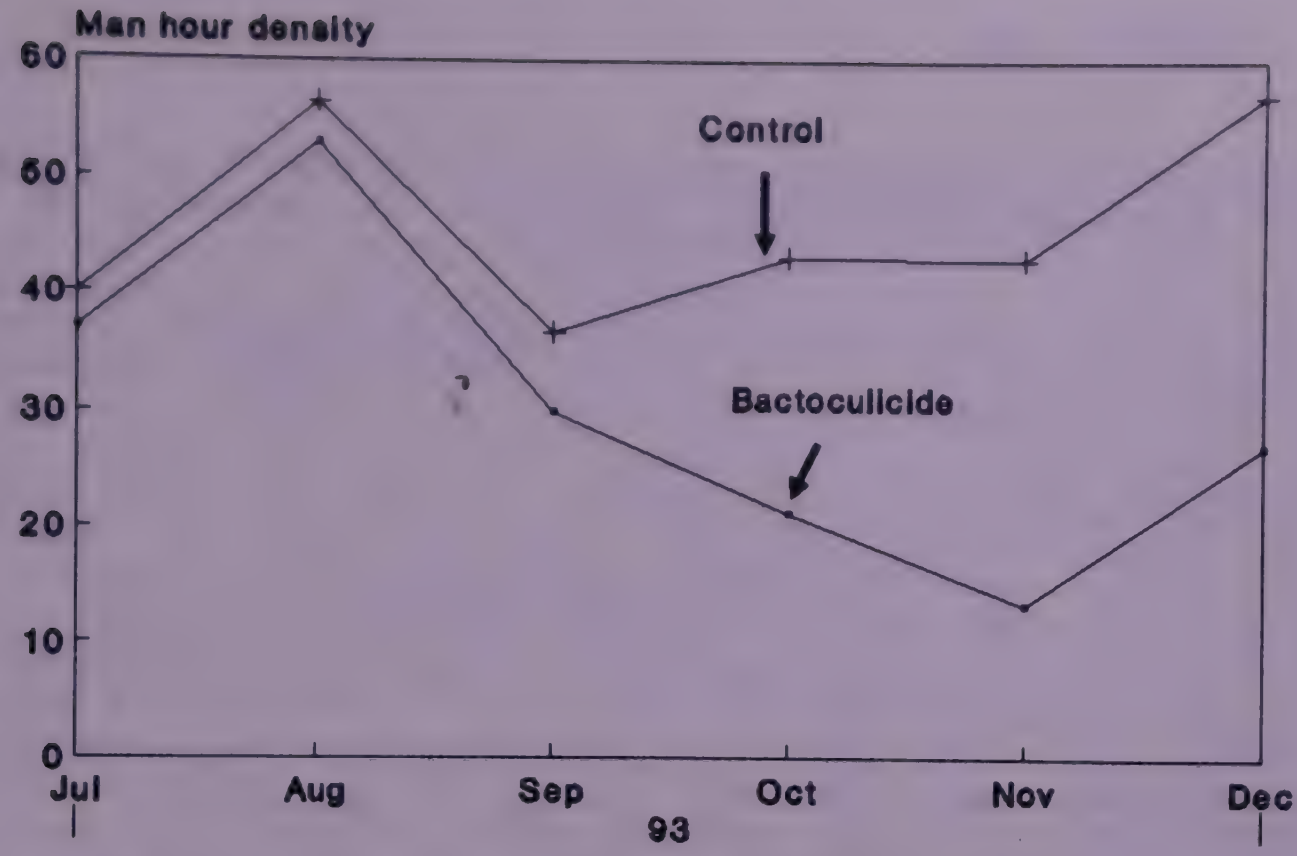


Fig. 27: Rourkela: Impact of spraying Bactoculicide on the indoor density of Cx. quinquefasciatus

use in mosquito control. There was a general appreciation among local residents about the new measure which in their perception caused relief against mosquito nuisance.

(XI) **PANJIM, GOA**

Anopheles stephensi and malaria control in Panaji with spherix Bacillus sphaericus strain B 101 serotype H 5a 5b : Panaji city of Goa is highly endemic for malaria. The problem of malaria in the city is largely construction related. Urban malaria vector An.stephensi breeds profusely in the curing waters and masonry tanks in constructions sites, wells, overhead tanks, sumps and ornamental fountains are other important sources of vector breeding. Field experiments to study the impact of Spherix on mosquito population and malaria transmission was launched in Miramar-Tonca locality of the city in 1993. In the rest of Panaji, where these habitats were treated with abate (Temephos 1ppm) by the NFCP Panaji unit was held as control. The study area, selected with the help of the State Health Services, has 28 active multistorey constructions and a work force of 490 migrant labourers (including families) residing in the hutments in the vicinity of construction sites. The population of local inhabitants in the study area is 5030. The rest of Panaji has a local population of 37,850 and 872 migrant labourers. Prior to the starting of biolarvicide experiment, all the chemical larvicides were withdrawn from the experimental area.

Spherix spraying: Miramar-Tonca localities of Panaji city spread over an area of approximately 2.0 sq km were brought under Spherix spraying. The habitat sprayed included all the major breeding sites such as curing waters, masonry tanks, underground tanks etc. preferred by the An.stephensi and septic tanks, drains, cess pits and cess pools preferred mostly by the culicines.

Impact on mosquito breeding: Prior to the application of Spherix the habitat positivity for anophelines and culicines in the experimental area increased from 1.1% and 11.01% respectively in January to 20.2% and 23.2% in April 1993. In comparison, the habitat positivity for anophelines in control area (Abate sprayed at 1 ppm) increased from 6.7% to 24.4% and for culicines from 11% to 22.41% during the same period. From most of the anopheline larval samples collected from the experimental and control area during the course of study, An.stephensi adults emerged when these larval samples were cultured in the laboratory.

Spherix spraying produced a visible impact as the habitat positivity for anophelines reduced to 8% in May and less than 1% after September 1993 (Fig. 1). Similarly the habitat positivity for culicines also declined sharply to 1.39% by November and it was only 0.43% in December 1993 (Fig. 2). On the other hand, the anpheline habitat positivity in control area increased to 30.6% in May and remained high i.e. 18.8% up to July and dropped subsequently to 2.2% in December. The diffe ence between the experimental and control area was highly significant ($p=0.008$). Similar trends were noticed for culicines ($p=0.011$).

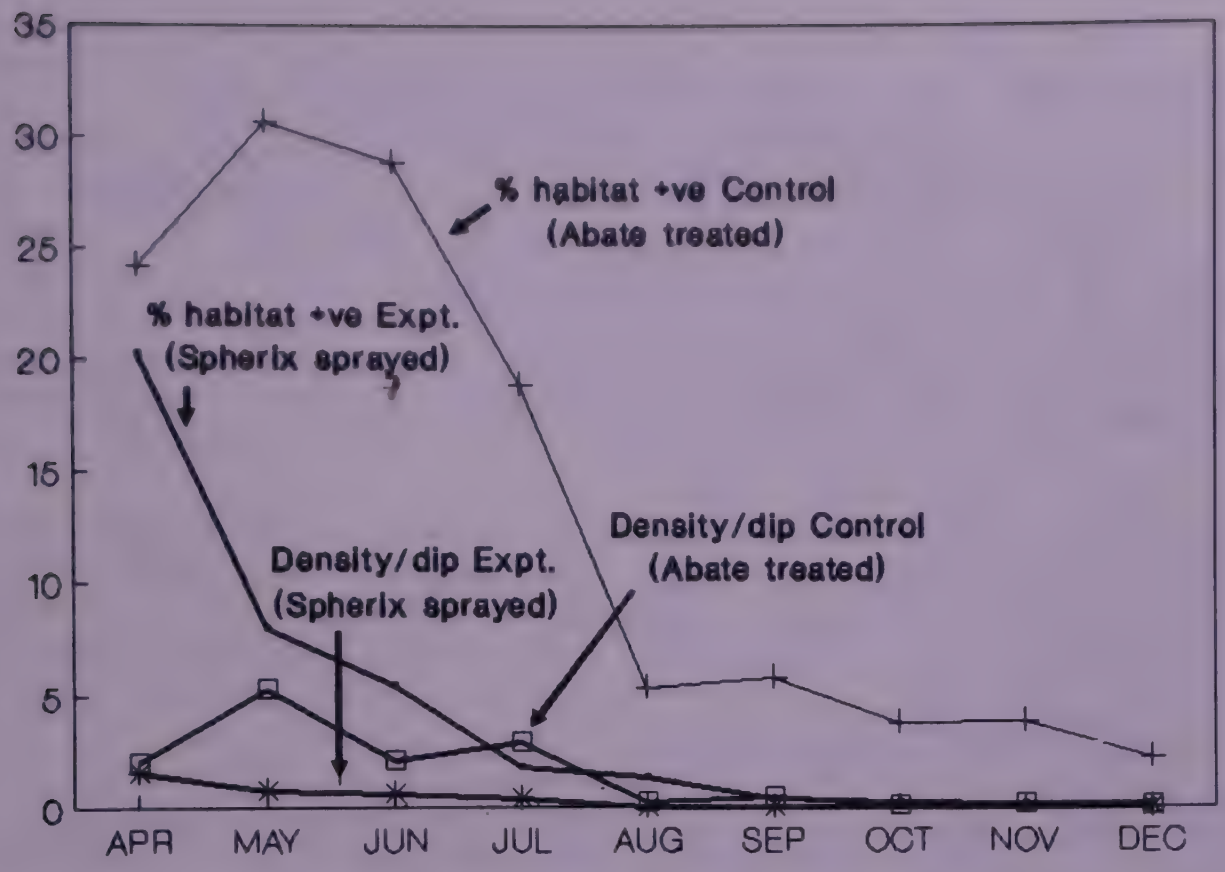


Fig. 1: Panaji: Comparison of per cent habitat positivity and density/dip of anophelines in constructions sites between experimental and control areas

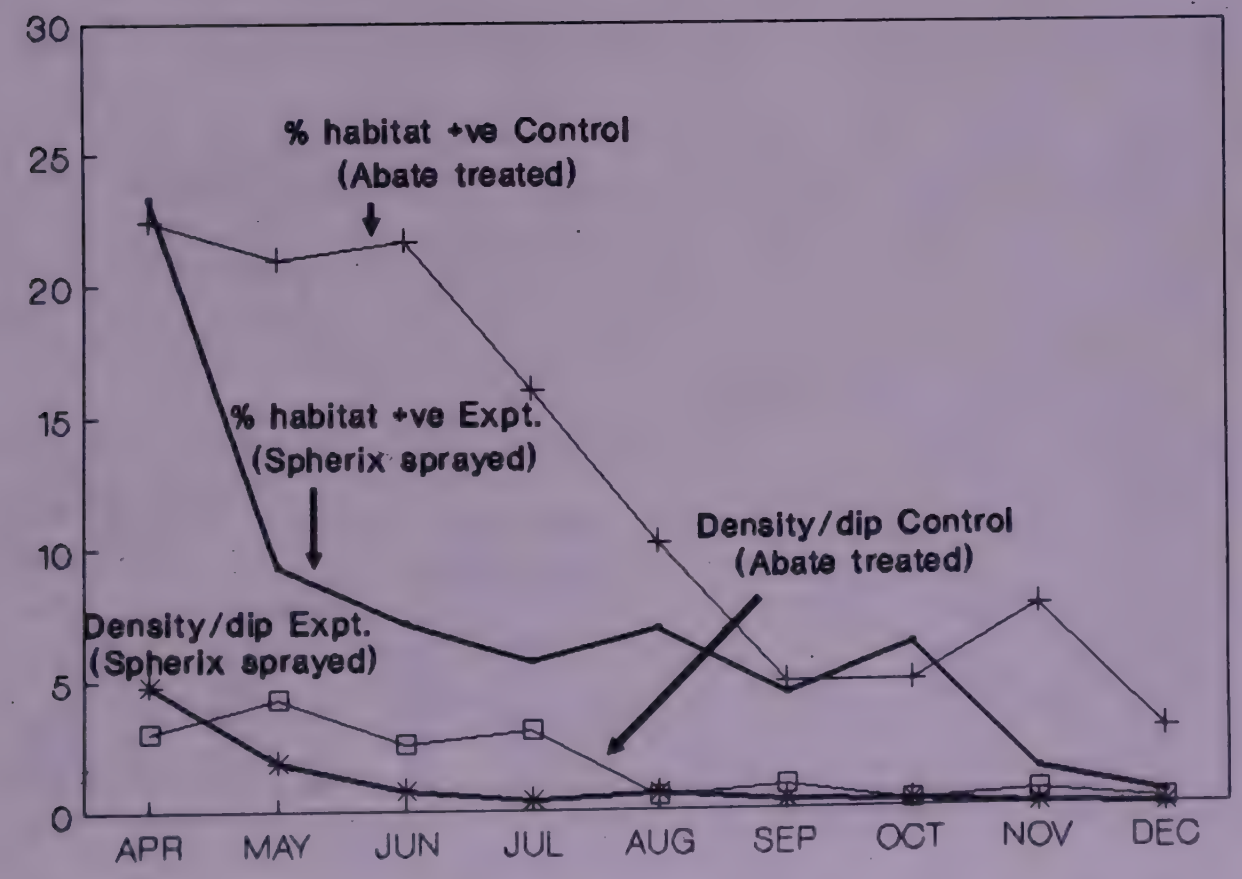


Fig. 2: Panaji: Comparison of per cent habitat positivity and density/dip of culcines in constructions sites between experimental and control areas

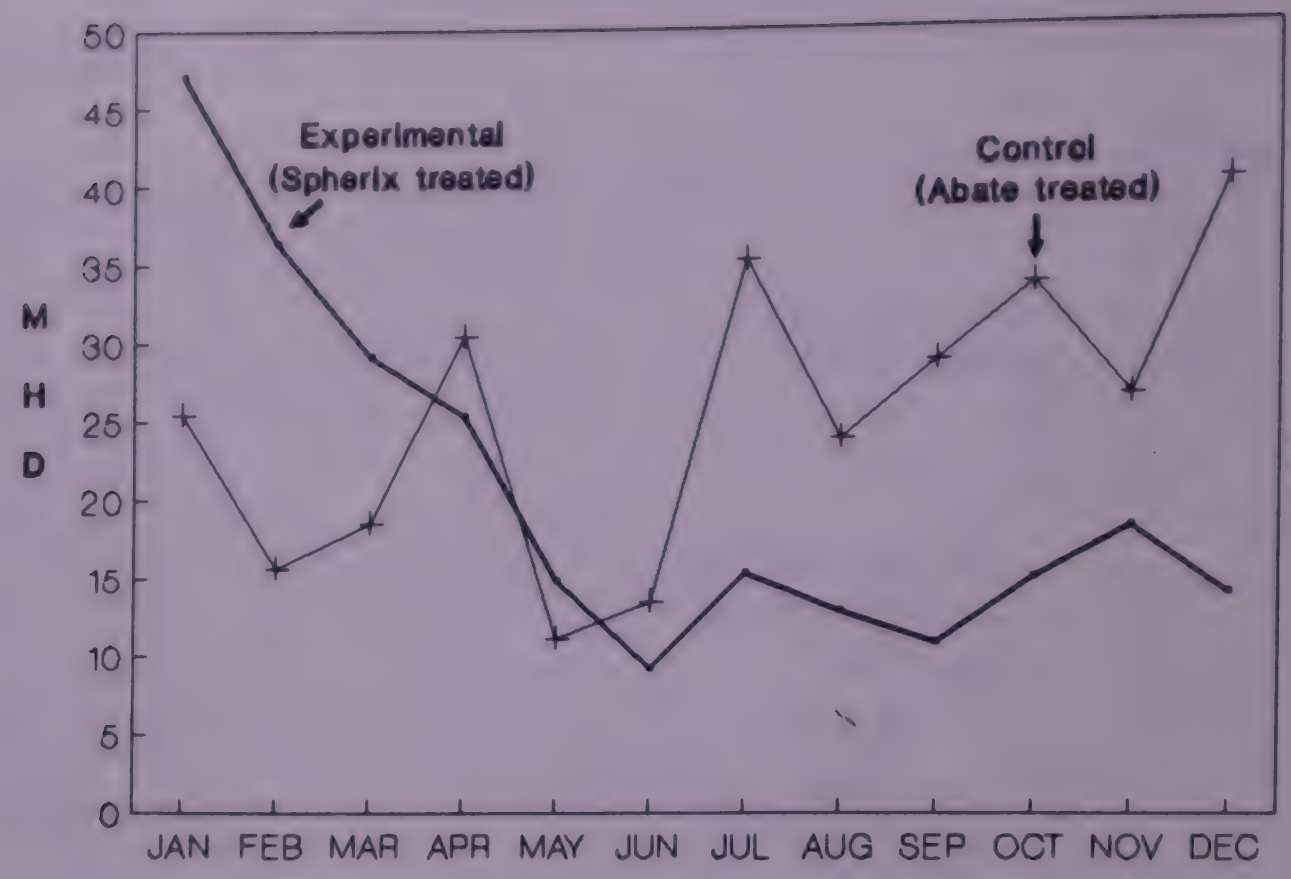


Fig. 3: Panaji: Comparison of man hour densities of mosquitoes in the pre- and post-application phase of spherix in the breeding habitats in experimental and control areas

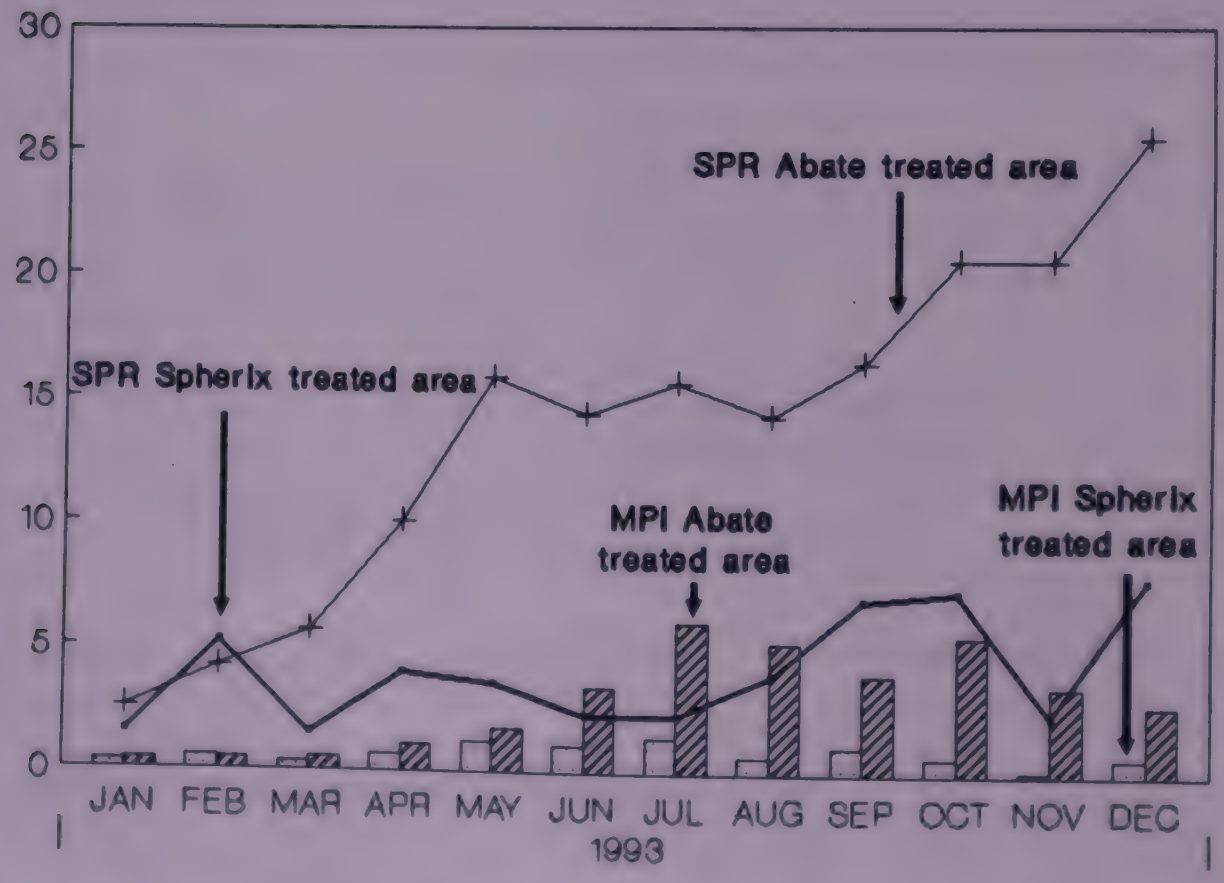


Fig. 4: Panaji: Comparison of slide positivity rate (SPR) and monthly parasite incidence (MPI) between spherix sprayed and control area

Spherix also produced a good impact on the densities of immatures in the larval habitats (Fig 1 & 2). The per dip densities of anophelines which had increased to 1.53 in April gradually declined to almost negligible from September onwards. In contrast, the density of anophelines in the control area went up to 5.0/ dip in May before gradually declining to 2.8/ dip in July and further in subsequent months. The difference in the densities between experimental and control areas was found significant (p=0.039). Similar trends were seen for the culicines densities (p=0.008).

Impact on the adult densities: Prior to the treatment with Spherix the man hour densities (MHD) of mosquitoes ranged from 25.3 to 47.15 from January to April in the experimental area. In the post application phase the densities declined from May to December and ranged from 9.1 to 18.2 (Fig. 3). Comparatively, the densities in the control area which ranged from 25.4 to 30.4 between January and April remained higher than the experimental area in most of the months (range 11.1 to 40.1). The difference in the mosquito densities was found statiscally significant between the two areas (p=0.0036).

Impact on malaria transmission: The parasitological data of the control and experimental area has been shown in Fig. 4. The SPR and MPI figures in the pre treatment months of January to April '93 were comparable with the Spherix and Abate sprayed areas. Subsequent to the commencement of Spherix spraying, the incidence of malaria remained well under control as is evident from the SPR (range 2.3 - 7.8) and MPI (0.18 - 1.44) figures as aginst the rest of Panaji (SPR range 14.3 - 25.5; MPI range 1.75 - 6.12). The overall SPR of experimental area was 3.27 as against 14.68 in the control area, similarly there was a visible impact on the incidence as the API in the rest of Panaji was 35.12 as against 9.22 recorded in Spherix sprayed area. The difference of SPR and MPI between the two areas from May to December was found to be highly significant (SPR: p=0.00003 and MPI: p=0.0032).

Reapplication rate: For the control of urban malaria, effective Spherix operations required in the construction sites which provide the most suitable niche for An.stephensi proliferation and transmission of the disease due to camping of labour in the vicinity. Curing waters and masonry tanks treated with Spherix were observed simultaneously every day for the status of immatures. Although, Spherix brought about absolute mortalities in 48h, yet the densities of immatures including those of III + IV and pupae picked up on the 7th day of post treatment which means that re-application is necessary every week in curing water and masonry tanks to check pupal production.

Demonstration of filaria control by Spherix spraying: Sada area of Vasco city of Goa is Filaria endemic and mosquito nuisance is immense. The Sada presents a pucca slum like situation and is inhabited by Vasco Port workers. There are large number of narrow

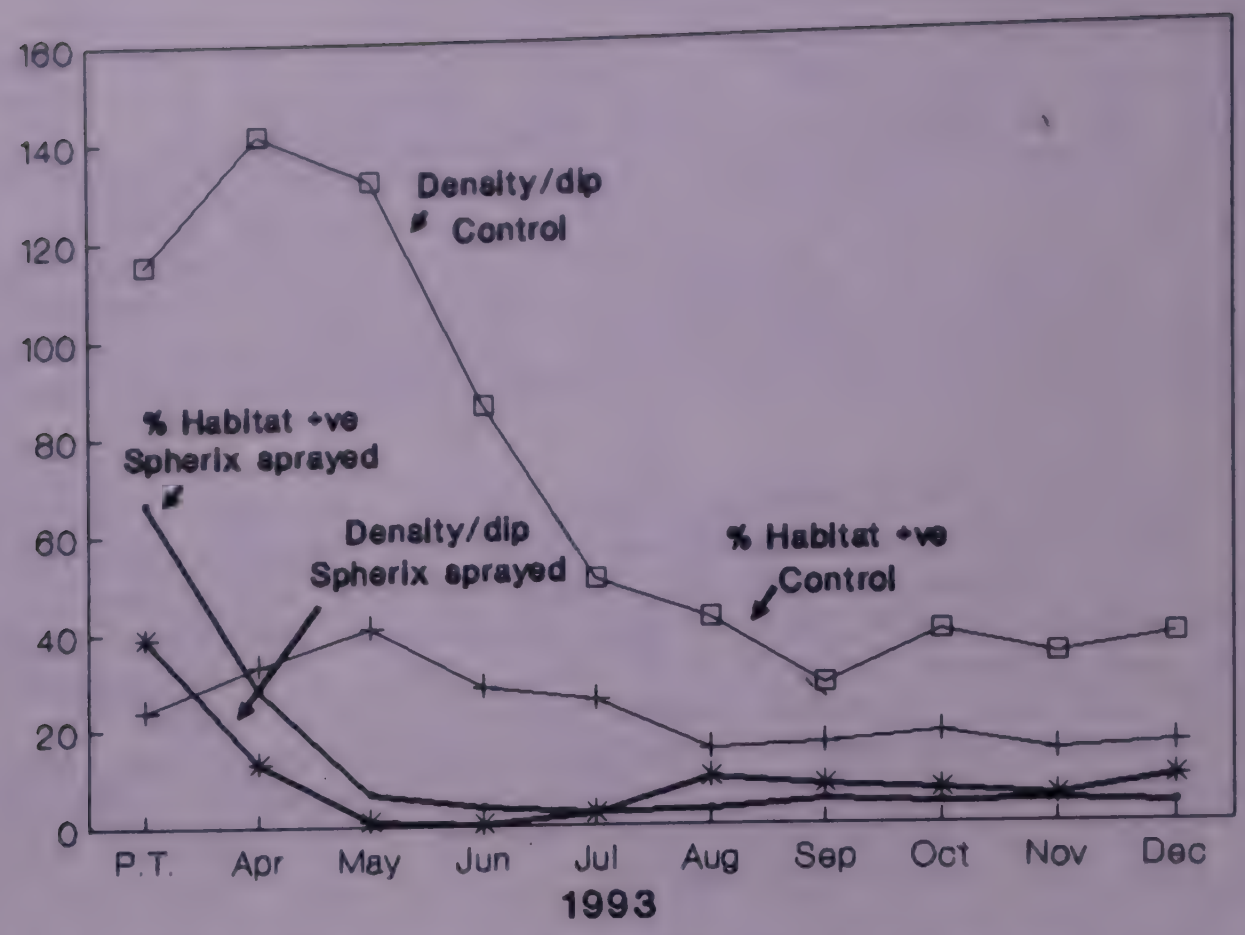


Fig. 5: Vasco city: Comparison of per cent habitat positivity and density/dip of culicines in experimental and control areas.

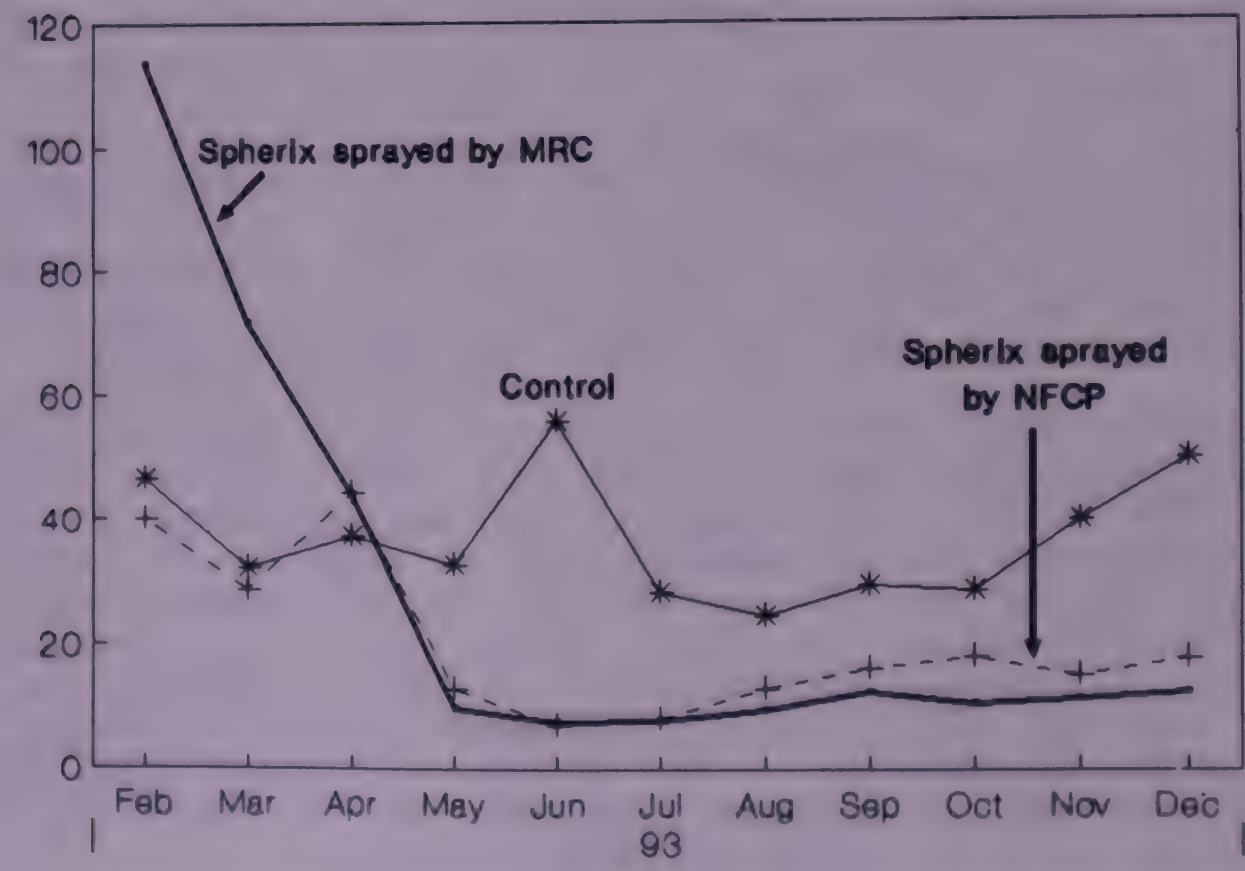


Fig. 6: Vasco city: Comparison of man hour densities of Culex quinquefasciatus in the pre- and post-application phase of spherix sprayed in the breeding habitats in the MRC, NFCP and control area

surface drains, main drains as well as cess pits. Due to the absence of underground sewage disposal system these storm water drains are also used to cary sewage water and these drains are quite often choked due to obstructions in the flow of water.

The State Health Services recommended Sada area for Spherix spray operation to demonstrate the control of Bancroftian Filariasis as well as the infectivity of filaria vector Cx.quinquefasciatus. This area is about 2 sq km. on a plateau surrounded on the three sides by the Arabian sea. Due to the tremendous mosquitogenic potential of this area, people complained bitterly about the mosquito menance at the time of commencement of Spherix spray operations.

Spherix spraying: The Sada area was divided in two equal parts (approx) one under the spray operations of MRC and other under that of NFCP (Vasco unit). Another area having more or less equal mosquitogenic potential was held as control. The spraying operations started on 20th April 1993 in MRC area and on 27th April in NFCP area. Initially all the cess pits, drains and cess pools were sprayed at a dose of 1gm/sq m. surface area; subsequently, however, only positive sites were sprayed at weekly intervals.

Impact on the Culex immatures: Prior to the commencement of spray operations the culicine habitat positivity in experimental area was 66.4 and 23.8% respectively (Fig 5). The habitat positivity in this area drastically reduced from the month of May onwards (range 2.69 to 6.6%) as comapred to control area (range 14.49 to 40.66%). Similar trends were witnessed in the per dip densities of III + IV instar larvae, the densities of which reduced from 12.17/ dip in the pre treatment period to 2.93/ dip by May and subsequently it remained low (range 0.29 to 3.09). On the other hand, the densities of III + IV instar in the control area remained significantly higher throughout (range 7.59 to 44.5/ dip). Consequently, the pupal production was much more in the control area in all the months (range 2.49 to 11.95/ dip) as compared to Spherix area (range 0.05 to 0.48/ dip). Thus overall mosquito potential of experimental area was lowered significantly.

Impact on adult Culex quinquefasciatus: The man hour densities (MHD) of filaria vector Cx.quinquefasciatus were monitored in the MRC and NFCP Spherix sprayed areas as well as in control area. The pre-treatment densities of Cx.quinquefasciatus were 113.4 and 71.2 in the months of February and March respectively in the MRC area (Fig 6). In April, it declined to 44.1 and from May to December the MHD ranged between 7.5 to 12.6. In the NFCP area the pre-treatment MHD in February and March were recorded as 40.1 and 28.7 which increased to 44.2 in April before delining in the post-treatment phase in all the months (range 7.2 to 18.1). In constrast the MHD of Cx.quinquefasciatus in the control area remained much higher throughout from May to December (range 24.5

TABLE 1: PANAJI: RESULTS OF CULEX quinquefasciatus DISSECTIONS IN THE EXPERIMENTAL AND CONTROL AREAS

Area	No. of mosquitoes dissected	No. positive	No. of mosquitoes with				Vector infection rate	Vector infectivity rate	X larvae/infected mosquito	X larvae(L3)/ infective mosquito
			m.f.	L1	L2	L3				
Experimental (Sada)	2504	5	2	1	1	1	0.2	0.04	7.6	2.0
Control (New Vaddem)	1533	1	1	0	0	0	0.06	0.0	2.0	0.0

TABLE 2: PANAJI: AGE AND SEXWISE DISTRIBUTION OF TOTAL CASES SURVEYED

Age group	Locals			Labourers		
	Female	Male	Total	Female	Male	Total
< 4	0	0	0	3	3	6
5 - 9	14	10	24	9	14	23
20 - 29	9	18	27	8	25	33
30 - 39	7	7	14	6	14	20
40 - 49	2	7	9	0	9	9
50 - 59	6	7	13	1	7	8
60 - 69	6	2	8	0	1	1
70 - 79	2	3	5	0	0	0
Total	46	54	100	27	83	100

- 56.0). The difference between MHDs of Cx.quinquefasciatus in MRC and NFCP, and control area was found to be significant (MRC: p=0.0019; NFCP: p=0.0078).

Vector infectivity rate : In the experimental area, out of 2504 Cx.quinquefasciatus females dissected 5 were positive with an infection rate of 0.2% (Table 1). Only one mosquito had L3 stage larvae therefore the infectivity rate was 0.04%. In the control area on the other hand only 1 female was found positive for mf with very low infection rate of 0.06%. The impact on the vector infectivity is likely to be clear in due course of time.

Re-application rate of Spherix : Re-application frequency of Spherix at the dose of 1 gm/ sq m. area was estimated in main drains, connecting drains and cess pits by doing sampling for immatures on days 0,1,3,7,14,21,28 and 35 post-treatment. In the large drains the pupal production ceased up to day 30th, in small drains up to day 14th and cess pits up to day 7th. Based on these observations, we recommend the re-application of Spherix at four week interval in large drains, at two week interval in connecting drains and weekly in the cess pits.

Socio-Economic studies on malaria

A study on various socio-economic aspects of malaria was conducted in malaria endemic Panaji city (area 7.5 sq km; population 49,215) during September and October 1993. A total of approximately 20,000 cases were recorded from this small city in the last eight years. In the present study 100 malaria patients each from local residents and migrant labour force representing either sex as well as different age groups (Table 2) were interviewed following a pre-designed inventory.

Broad conclusions: i) A very high dependence on allopathic system of medicine was found amongst local (100%) and labourers (98%) alike. ii) Malaria problem was prevelant amongst all the economic classes in Panaji although it was more prevalent amongst poor (47%) as compared to people with average (43%) and high income group (2%). Expectedly bulk of the labourers suffering from malaria were from the poor income group (93%). iii) The main source of vector breeding amongst the local residents were wells and overhead tanks although they may have been indirectly affected by the vector production from the construction which served as the main source of vectors for the labourers. iv) The DDT spray coverage with labour hutments was very good (89%). 19%, 9% and 61% of labour hutments received one, two and three rounds of sprays respectively but it seems no particular spray schedule was followed. Although 92% of the houses of locals were suitable for spraying only 59% of the local patients informed that their houses were sprayed subsequent to the detection of their cases. The epidemiological significance of this selective excercise is

TABLE 3: PANAJI: DIFFERENT PERSONAL PROTECTION METHODS USED BY THE STUDY GROUP

Method of Protection	Locals (%)	Labourers (%)
Bednets	3	1
Coils	55	2
Mats	21	0
Space spray	4	0
Creams	2	2
Dhup	4	0
Oils	0	0

TABLE 4: PANAJI: ACTIVE CASE DETECTION FREQUENCY IN THE LABOUR CAMPS AND AMONGST LOCAL RESIDENCE

Frequency	Locals (%)	Labourers (%)
0	56	12
15 days	1	65
1 Month	2	18
2 Months	0	1
3 Months	2	1
6 Months	10	1
12 Months	29	2

TABLE 5: PANAJI: DELAYED TREATMENT DUE TO DELAY IN DIAGNOSIS

Days	Local (%)		Labourers (%)	
	Diagnosis	Treatment	Diagnosis	Treatment
0	7	0	4	0
1	13	5	5	5
2	19	0	11	1
3	27	18	39	6
4	15	1	16	0
5	5	6	9	3
6	1	67	2	82
7 - 10	7	1	10	2
11 - 20	6	2	1	1
21 - 30	0	0	2	0
30<	0	0	1	0

not clear. A good incidence of malaira amongst labourers in spite of the good coverage might be due to vector resistance to DDT (Thavaselvam et al, 1993). v) The dependence of local residents on coils and mats was very high and bednets were not popular. On the contrary, the labourers did not depend much on any of the personal protection methods (Table 3). Given the preference 64% of locals showed preference for alternate protection methods other than spraying although 58% of labourers did not know what to do (Fig 7). vi) The active case detection was extremely poor among the local residents and in their case, dependence on passive agency was therefore quite high. On the other hand, 65% labourers informed that surveillance frequency was fornightly and another 18% declared it to be monthly (Table 4). Thus there is room for strengthening active case detection especially amongst labourers and in selective sensitive areas amongst locals. vii) Two factors i.e. delay in diagnosis and irregular/ incomplete treatment which has bearing on malaria transmission were found in many cases among both the demographic groups (Table 5). viii) Per capita loss amongst the locals was very high (Rs. 621.25) and inspite of poor wages of the labourers the loss appeared enormous of Rs. 249. Among labourers 88% accounted for wage loss whereas in locals 58.5% was due to wage loss and another 20% was spent as constitution fee (Table 6). ix) There was a considerable loss of studies among children of both the groups locals (X= 12.5 days) as well as labourers (X = 6.5 days). One engineering student could not appear in the final examination and another school

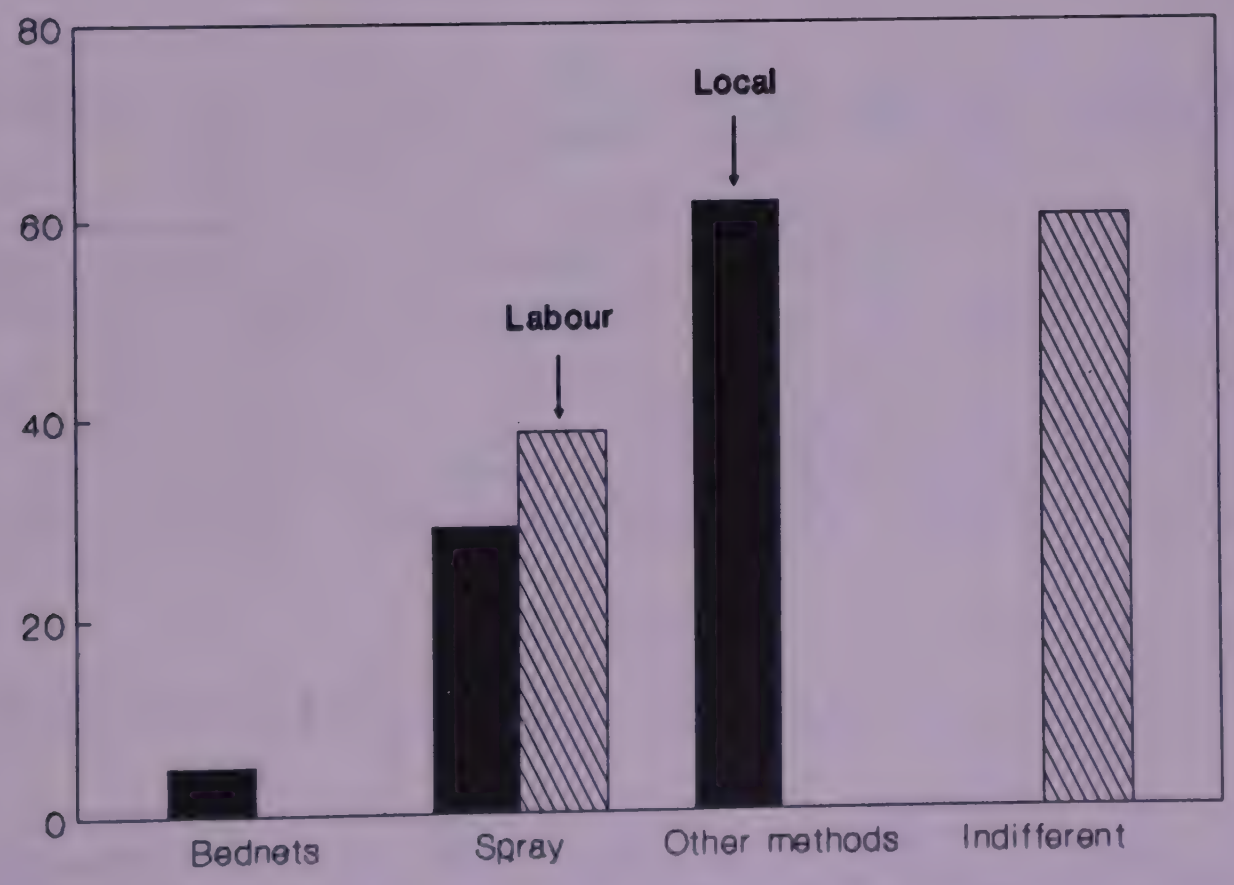


Fig. 7: Panaji: Preference for personal protection methods against mosquito bites

TABLE 6: PANAJI: PER CAPITA LOSS DUE TO MALARIA (IN Rs.)

Expenditure/Loss	Locals		Labourers	
	Mean	Range	Mean	Range
Consultation	124.3	0-3500	9.1	0-100
Medicine	34.3	0-500	10.08	0-200
Lab. test	19.7	0-250	3.45	0-100
Transport	17.24	0-90	2.86	0-30
Special food	6.28	0-200	0.83	0-50
Tonics	22.43	0-400	2.63	0-50
Wages	363.50	0-6000	219.40	0-1500
Nursing related	0.5	0-50	0.74	0-50
Miscellaneous	33.0	0-1600	0.0	0

TABLE 7: PANAJI: WORKLOSS DUE TO MALARIA (MAN/DAYS/SCHOOL DAYS)

Particulars	Locals		Labourers	
	Mean	Range	Mean	Range
School days	12.75	0 - 30	6.5	0 - 100
Man days	12.86	0 - 60	9.05	0 - 60

TABLE 8: PANAJI: PERSONAL PROTECTION PROVIDED BY NEEM OIL BY TOPICAL APPLICATION AND BURNING IN KEROSENE/LAMPS

Concentrations	Crude Neem oil + Coconut oil	Crude Neem oil + Mustard oil	Ayurvedic Neem oil+ Coconut oil	Ayurvedic Neem oil + Mustard oil	Neem oil+ Kerosene
0.5%	50.0	47.7	41.8	38.9	26.2
1.0%	40.1	59.5	36.3	47.7	24.4
2.0%	38.8	46.4	29.1	31.1	52.9
3.0%	-	-	-	-	29.7
5.0%	-	-	-	-	75.6
7.0%	-	-	-	-	34.5
10.0%	-	-	-	-	5.9

student was unable to write terminal examination. A teacher had to miss NCERT workshop due to malaria problem. On an average locals lost 12.86 man days as against 9.05 days by labourers (Table 7).

Evaluation of Neem oil for its repellent action

Two preparations of Neem oil, crude extract and ayurvedic form were tested for their repellent action against mosquitoes. Three concentrations, 0.5%, 1.0% and 2.0% were prepared for each Neem preparation in Coconut oil and Mustard oil for their topical application on the human baits. Experiments were also conducted by burning crude Neem oil with kerosene in lamps at 0.5%, 1.0%, 2.0%, 3.0%, 5.0%, 7.0% and 10.0% concentrations. The field experiments were conducted following four x four contigency table by rotating bait, insect collector, concentrations and collection structures to minimize the bias arising due to these factors. To each bait, 10 ml of each concentration was applied on the exposed body parts and mosquitoes landing on them were collected by the insect collectors. The results of experiments were compared with the control in which only Coconut oil or Mustard oil were applied and mosquitoes were collected in a similar fashion as above. The total collection involved 12 hours from 1800h to 0600h. The mosquitoes collected during each hour were kept separately and were identified in the laboratory following the standard keys.

Results of the study: Results have been summarized in Table 8. It is evident that maximum protection of 59.5% was provided by 1.0% crude Neem oil mixed with Mustard oil. In general, the efficacy of oil reduced with the increase in the concentration as per cent protection at 2.0% was less than 1.0% in all the cases. Crude Neem oil appeared to the marginally better than the ayurvedic Neem oil (Fig. 8).

The per cent protection by burning 2.0% Neem in kerosene lamp provided 52.9% protection there was significant reduction of efficacy at 3.0% concentration (29.7%) although it increased considerably at 5.0% concentration to the extent of 75.6%. The efficacy, however, reduced significantly at 7.0% and 10.0% concentration (34.5% and 5.9% respectively). The reason for sudden reduction in protection at 3.0% was not clear (Fig. 9).

It was found that in spite of the application of Neem oil mosquitoes continued to land on the treated host throughout the night at all concentrations. Similar phenomenon was seen when neem was burnt at different concentrations with the kerosene oil (Fig 10 a, b, c & d).

Monitoring of Malaria in Panaji

Malaria problem started in Panaji in the year 1986 and took a very serious turn by the year 1988 (API = 132). With the introduction of bioenviromental control in 1989 the incidence gradually decreased and in 1992 only 445 cases of malaria were

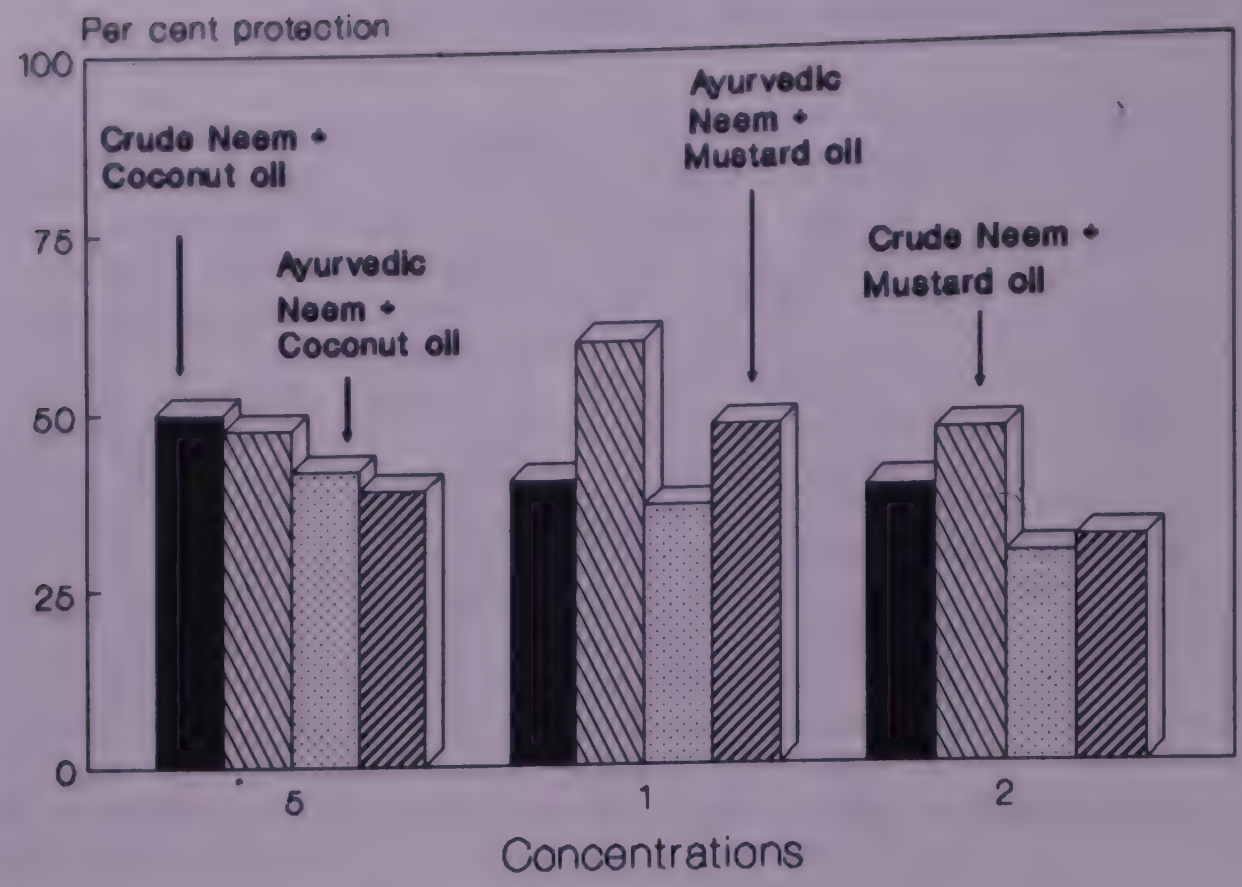


Fig. 8: Panaji: Personal protection from mosquitoes provided by the different concentrations of Neem oil burnt in kerosene lamps

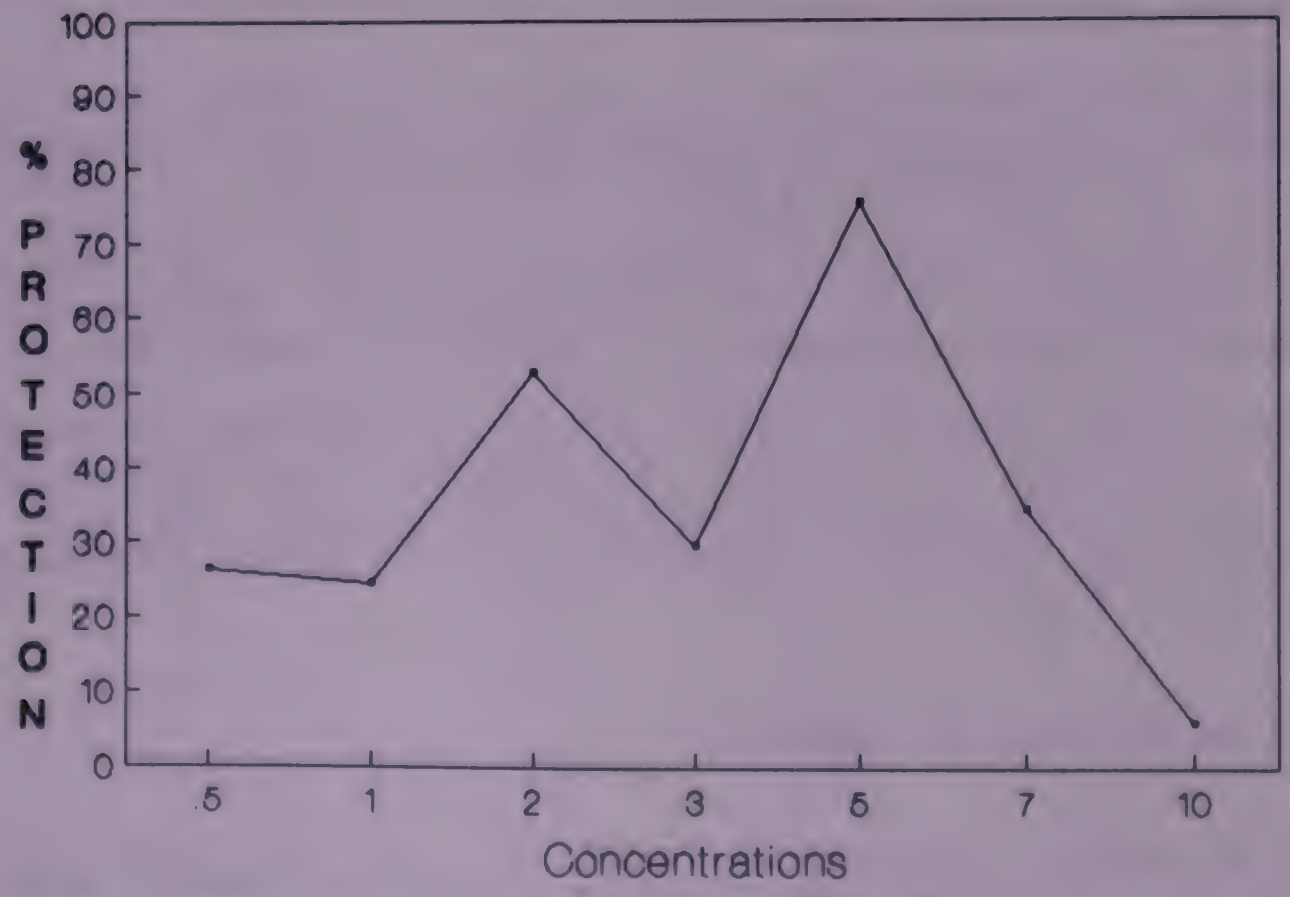


Fig. 9: Panaji: Repellent effect of crude and ayurvedic preparations of neem mixed in Coconut and Mustard oil

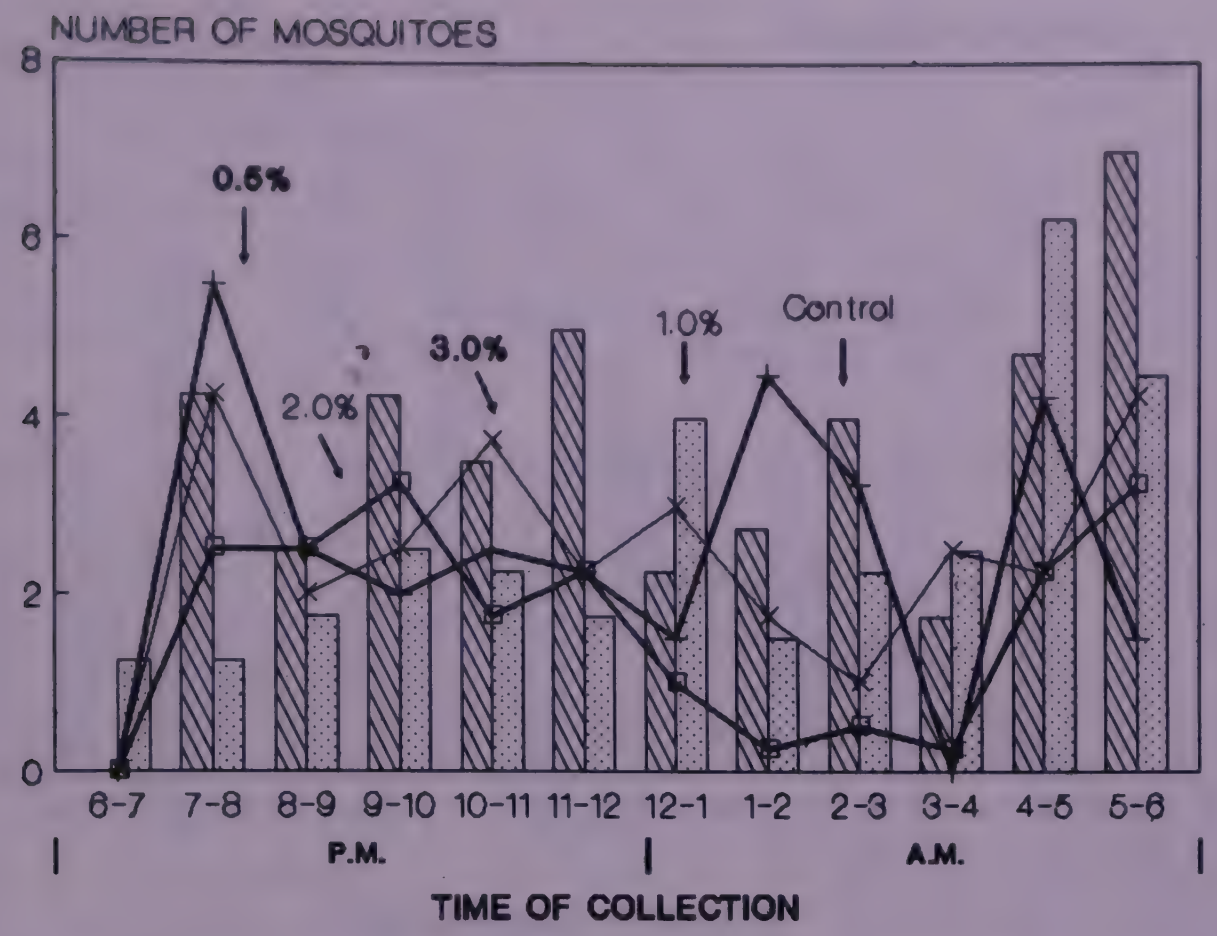


Fig. 10A: Panaji: Protection from mosquito bites by burning Neem oil with kerosene

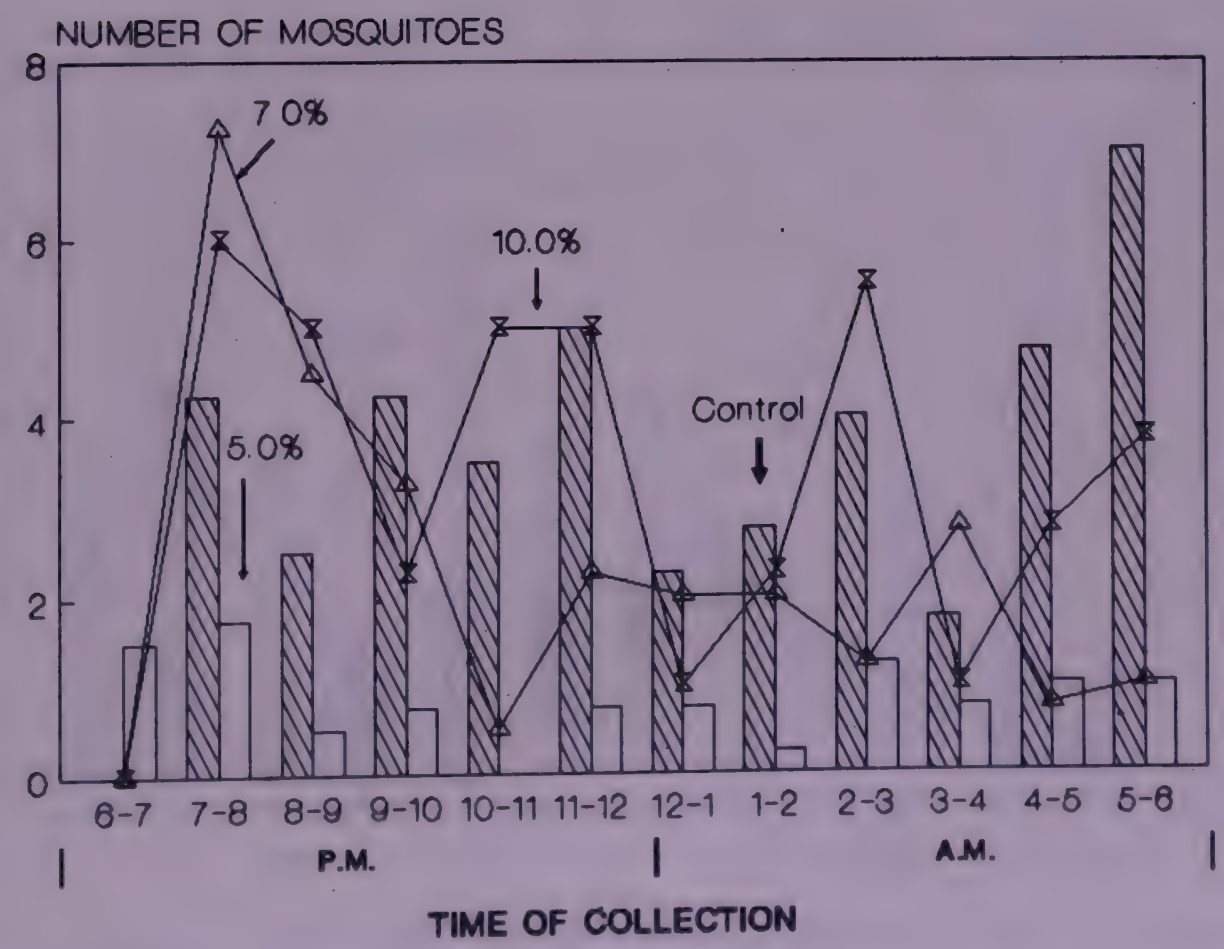


Fig. 10B: Panaji: Protection from mosquito bites by burning Neem oil with kerosene

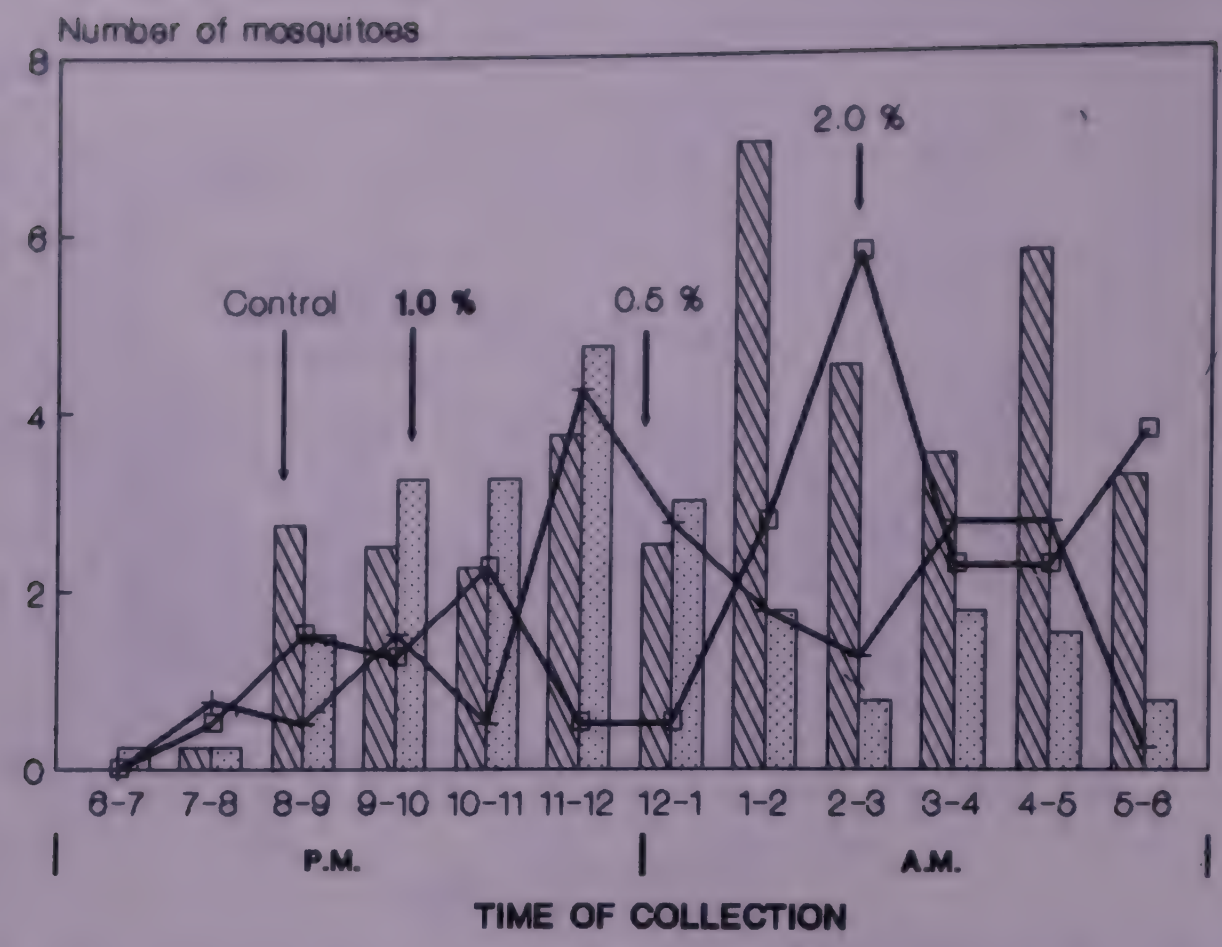


Fig. 10C: Panaji: Protection from Neem with Mustard oil against mosquito bites

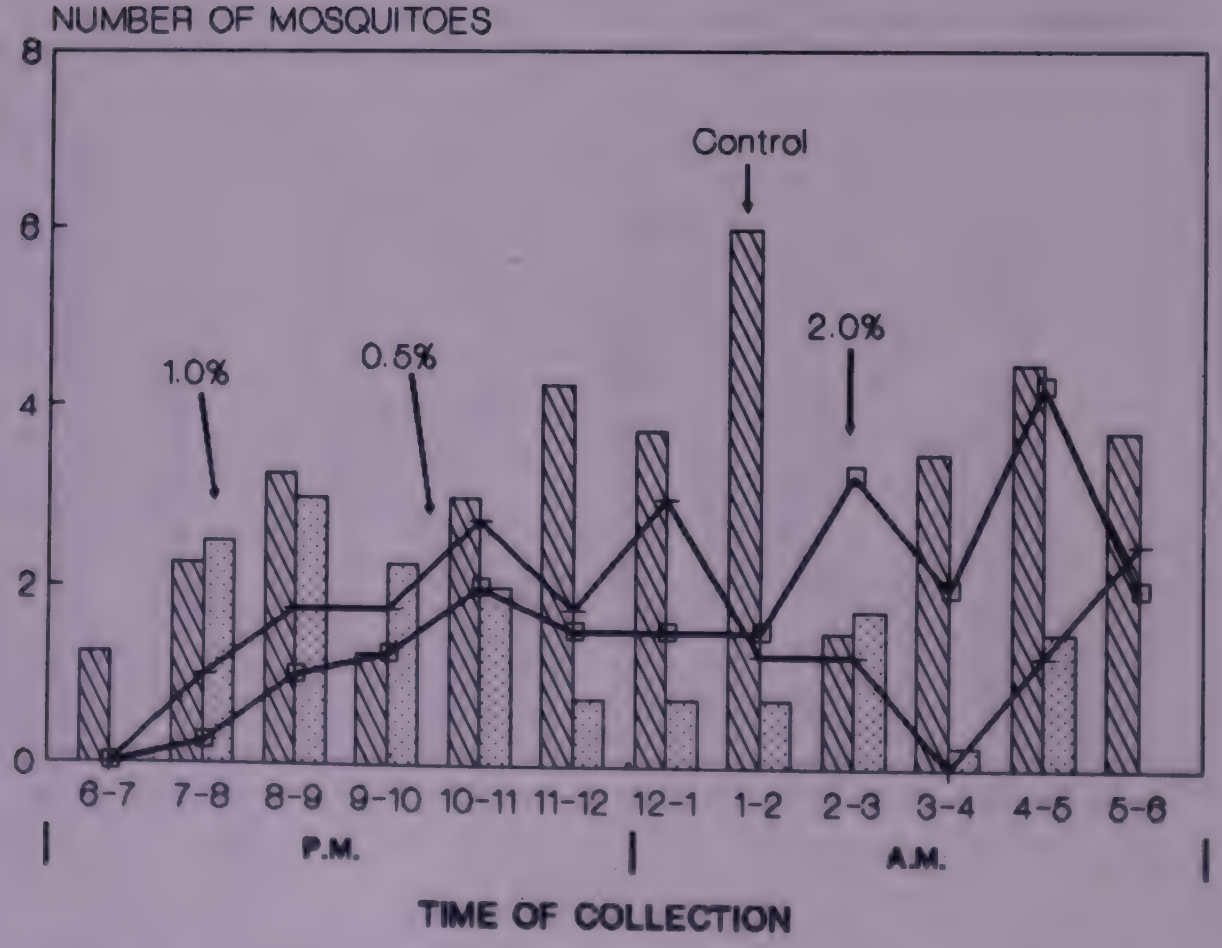


Fig. 10D: Panaji: Protection from Neem with Coconut oil against mosquito bites

reported with API of 10.36 (Table 9). The bioenvironmental control measures were withdrawn in 1993 and it was seen that the malaria situation once again worsened with 1411 cases and an API of 32.8. The monthwise picture shows that very active transmission took place from May onwards and a total 314 P.falciparum cases were reported (Table 10). The SPR which was very low in the beginning of the year gradually increased to 23.4%. Similarly, SFR increased to 8.29% in December 1993. Keeping these trends in view a blue print on the lines of

TABLE 9: PANAJI: PARASITOLOGICAL DATA OF PANAJI (1984 TO 1993)

Year	BSE	Pos	Pv	Pf	Mixed	SPR	SfR	API
1984	1775	7	7	0	0	0.40	0.00	0.16
1985	2506	6	6	0	0	0.24	0.00	0.14
1986	6539	352	351	1	0	5.38	0.02	8.18
1987	21710	4406	3999	7	0	20.29	0.03	102.43
1988	29853	5677	5435	242	0	19.01	0.81	132.05
1989	20976	3523	2903	520	0	16.80	2.47	82.00
1990	19147	3780	3055	710	15	19.70	3.79	88.03
1991	10294	1554	1486	63	4	15.10	0.66	36.20
1992	7058	445	352	88	3	6.30	1.28	10.36
1993	10822	1411	1097	312	2	13.00	2.90	32.80

TABLE 10: PANAJI: PARASITOLOGICAL DATA (1993)

Month	BSE	Pos.	Pv	Pf	SPR	SfR	MPI
Jan	767	18	12	6	2.3	1.27	0.41
Feb	489	21	17	4	4.3	0.81	0.48
Mar	521	24	21	3	4.6	0.57	0.55
Apr	536	48	48	0	8.9	0.00	1.11
May	621	75	71	4	12.0	0.64	1.74
Jun	1197	141	128	13	11.7	1.08	3.28
Jul	1853	245	198	47	13.2	2.53	5.70
Aug	1536	209	178	31	13.6	2.01	4.87
Sep	1025	161	120	41	15.7	4.00	3.75
Oct	1097	219	140	79	19.8	7.20	5.10
Nov	710	139	92	47	19.4	6.60	3.20
Dec	470	111	72	39	23.4	8.29	2.60
Total	10822	1411	1097	314	13.0	2.9	32.80

Integrated Disease Vector Control was prepared for Goa especially applicable to urban and sub-urban areas which has been submitted to the National Malaria Eradication Programme, Delhi for implementation in Goa.

(XII) CAR NICOBAR, A & N ISLAND

Malaria in Car Nicobar Island has substantially reduced during 1993. During this year total number of positive cases recorded from this Island was 340 showing an API of 16.91. Before implementation of Bioenvironmental control strategy the API was varying from 60 to 140 till 1989; since then there was a considerable decline in malaria incidence (Table 1). In the history of malaria in Car Nicobar Island, this is the lowest API recorded so far.

Table 2 gives the work done under Bioenvironmental control strategy. In marshy and creeky areas fishes (Gambusia affinis) are being released. To tackle the breeding of An. sundaicus in creeky and marshy areas, intensified anti-larval operation with Bacillus sphaericus (Spherix) has been introduced in the Island.

Biological Control: An extensive fish fauna survey of Car Nicobar Island was carried out and the per cent composition of fishes in different habitats were recorded (Table 3). The specimen were identified by Zoological Survey of India. Till now 27 species have been identified and their larvivorous capacity has been studied (Table 4). Of these potential larvivorous species are Ophiocara aporos, Ophiocara porocephala, Megalops cyrinoides, Anabas testudineus, Oreochromis mossambica and Aplocheilus panchax. Fish fauna survey is still in progress.

Large stocks of Gambusia affinis have been raised. At present there are 12 established hatcheries in different villages. One hatcheries can supply fishes to 2 to 3 villages. Situation specific larvivorous fishes have been extensively released in different mosquito breeding habitats (Table 5).

Supply of Gambusia affinis to Andaman and Nicobar Island: As per the request of Medical Officer, Incharge, Campbell Bay, Primary Health Centre, five thousand Gambusia affinis were supplied to Campbell Bay for establishment of hatcheries and its subsquent release into different mosquito breeding habitats. Five thousand Gambusia affinis were also supplied to Directorate of Health Services, Port Blair, as per the request of Deputy Director of malaria, Andaman and Nicobar Administration for the establishment of hatcheries.

Entomological Investigations: The mosquito fauna of Car Nicobar Island so far recorded consists 20 species belonging to 6 genera namely Anopheles, Aedes, Armigeres, Culex, Mansonia and Toxorhynchites. The most prevalent genus in the Island is Anopheles which consists of four species.

1. Anopheles sundaicus
2. Anopheles barbirostris

TABLE 1: CAR NICOBAR: EPIDEMIOLOGICAL DATA FROM 1988 TO 1993

Year	Population	BSC	ABER	Total +ive	Pf	Mix	SPR	SfR	API	AfI	Pf%	Rainfall (mm)
1988	19298	276770	143.4	3149	1831	33	11.38	6.60	163.2	95.0	58.0	3535.0
1989	19597	319200	162.0	3810	2392	46	11.93	7.46	194.4	121.50	62.5	2332.2
1990	20287	29279	144.3	1658	488	38	5.66	1.67	81.7	24.0	29.4	1834.8
1991	19252	20792	108.0	946	441	31	4.5	2.12	49.1	23.0	46.6	2747.5
1992	19252	17694	91.9	636	276	-	3.6	1.50	33.0	14.3	43.4	2060.2
1993	20102	14412	71.7	340	153	4	2.36	1.06	16.91	7.61	45.0	2256.8

TABLE 2: CAR NICOBAR: PROGRESS AT A GLANCE (1992-93)

Total village covered	:	19
Population protected .	:	19252
Source Reduction		
Margins cleaned	:	473
Ditches filled	:	53
Drains cleaned	:	512
Channalization	:	87
No. of tractor load used	:	4
No. of hours buldozer used	:	-
No. of hours tractor used	:	8 h
Construction of pond	:	2
Biological Control		
Hatcheries established	:	9
Hatcheries maintained till date	:	14
Estimated number of fishes in hatcheries	:	1 million app.
No. of Larvivorous fishes introduced	:	249900
Health Education		
Health camps arranged	:	6
Group meetings held	:	375
Health education in schools	:	2

3. Anopheles insulaeflorum
4. Anopheles barbumbrosus

An.sundaicus is the most predominant species. An.sundaicus and An.barbirostris were reported earlier. An.insulaeflorum and An.barbumbrosus are the new addition to the present Anopheles fauna.

The man hour densities (MHD) of An.sundaicus collected fortnightly from January to December 1993 revealed that the densities of An.sundaicus is very low in experimental area throughout the year except during the second fortnight of November month when density recorded was 2.91 per man hour (Table 6). In control area the species is prevalent throughout the year and the density ranges from 0.16 to 64.83 per man hour. However, during the first fortnight of April the density of An.sundaicus was recorded zero. The high density was recorded from the month of May to December.

TABLE 3: CAR NICOBAR: PER CENT COMPOSITION OF FISHES IN DIFFERENT HABITATS

S.No.	Species	Ponds	Nallah	Stream	Creek	Creek pools
1.	Aplocheilus panchax	-	0.57	-	-	-
2.	Apogan hylosoma	1.70	-	-	2.01	-
3.	Anabas testudineus	-	9.33	-	4.92	-
4.	Acentrogobius viridipunctatus	-	-	-	6.16	-
5.	Ambassis interrupta	-	-	-	1.88	-
6.	Arothron reticularis	-	-	-	0.41	-
7.	Butis butis	-	-	-	2.87	-
8.	Chanos chanos	-	-	-	1.57	-
9.	Kuhila rupestris	-	-	14.17	5.03	9.88
10.	Liza macrolepis	-	-	-	0.81	-
11.	Lutjanus argentimaculatus	-	-	-	1.11	-
12.	Megalops cyprinoides	-	-	9.46	13.19	14.10
13.	Monodactylus argenteus	-	-	-	0.50	-
14.	Ophiocara poracephala	-	-	6.38	14.05	35.75
15.	Ophiocara aporos	98.30	90.10	72.99	15.77	40.47
16.	Oreochromis mossambica	-	-	-	-	-
17.	Pomacentrus lividus	-	-	-	0.23	-
18.	Raramia quinouelineata	-	-	-	2.00	-
19.	Secutor insidiater	-	-	-	1.10	-
20.	Sillago sihama	-	-	-	2.01	-
21.	Sphuraena obtusata	-	-	-	0.40	-
22.	Syngnathus spicifer	-	-	-	2.17	-
23.	Therapan jarbua	-	-	-	1.99	-
24.	Tetradon cutcutia	-	-	-	2.00	-
25.	Valamugil seheli	-	-	-	12.39	-
26.	Zenarchopterus buffonis	-	-	-	3.00	-
27.	Zenarchopterus gilli	-	-	-	2.00	-
	Total collected	285	98	42	240	51

TABLE 4: CAR NICOBAR: LARVIVORACITY OF LOCAL FISH FAUNA

S. No.	Fish species	Availability	Larvivorous potential
1.	Aplocheilus panchax	Less	++++
2.	Apogan hylosoma	Less	++
3.	Anabas testudineus	Moderate	++++
4.	Acentrogobius viridipunctatus	Moderate	+++
5.	Ambassis interrupt	Less	++
6.	Arothron reticularis	Rare	+
7.	Butis butis	Less	-
8.	Chanos chanos	Less	-
9.	Kuhlia rupestris	Moderate	+++
10.	Liza macrolepis	Less	++
11.	Lutjanus argentimaculatus	Less	+
12.	Megalops cyprinoides	Moderate	++++
13.	Monodactylus argenteus	Rare	++
14.	Ophiocara poracephala	Plenty	++++
15.	Ophiocara aporos	Plenty	++++
16.	Oreochromis mossambica	Moderate	++++
17.	Pomacentrus lividus	Rare	++
18.	Raramia quinouelineata	Less	+
19.	Secutor insidiater	Less	++
20.	Sillago sihama	Less	++
21.	Sphyraena obtusata	Rare	+
22.	Syngnathus spicifer	Less	-
23.	Therapan jarbua	Less	+++
24.	Tetradon cutcutia	Less	-
25.	Valamugil seheli	Plenty	+++
26.	Zenarchopterus buffonis	Less	+
27.	Zenarchopterus gilli	Less	+

Note : Consumption of larvae per day 100 or more = ++++
75 - 99 = +++
50 - 74 = ++
25 - 49 = +

Larval survey: Larval collections were carried out in the Island in 1993. A total number of 37,405 breeding sites were searched, out of these 434 supported breeding of An.sundaicus (Table 7). There are 609 used wells. These wells were monitored weekly for mosquito breeding. Immature stages of An.sundaicus were encountered in 8 (1.31%) wells. Ophiocara aporos and Gambusia affinis were introduced @ 5 and 10 fishes/ wells. Occasionally, I and II instar larvae were recorded.

The composition of different anopheline species in different breeding habitats were also recorded. The maximum breeding of An.sundaicus was recorded in creek, marshy area, ponds and cement tanks (Table 8).

TABLE 5: CAR NICOBAR: LARVIVOROUS FISHES RELEASED FOR MOSQUITO CONTROL

S. No.	Species	Larval habitats	Remarks
1.	Ophicara aporos	Wells, Ponds, Pools	Potential larvivorous fishes for control of mosquito breeding in wells
2.	Kuhlia rupestris	Wells, Creek pools	Potential larvivorous fishes in control of mosquito breeding in brakish water and fresh habitats
3.	Megalops cyprinoides	Creek, Creek pools	"
4.	Aplocheilus panchax	Cement tanks, Ponds Pools, Marshy area	"
5.	Oreochromis mossambica	Cement tanks, Ponds	"
6.	Gambusia affinis	Ponds, Pools, Tanks, Creeks, Wells	"

TABLE 6: CAR NICOBAR: RESULTS OF MONITORING OF MOSQUITO DENSITIES

Fortnight Month		Area with bioenvironmental control				Area without bioenvrionemtal control			
		Mosquitoes	Culex	Anopheles	Vector	Mosquiotoes	Culex	Anopheles	Vector
Jan 93	I	10.33	10.33	0.00	0.00	16.30	2.50	13.85	13.85
	II	26.13	26.13	0.00	0.00	11.55	2.78	8.77	8.77
Feb 93	I	9.65	8.99	0.66	0.66	2.53	0.92	1.61	1.61
	II	4.33	4.33	0.00	0.00	2.83	2.67	0.16	0.16
Mar 93	I	8.24	8.24	0.00	0.00	0.71	0.27	0.44	0.44
	II	10.99	10.99	0.00	0.00	8.10	1.11	6.99	6.99
Apr 93	I	9.37	9.37	0.00	0.00	6.82	6.82	0.00	0.00
	II	11.29	10.92	0.37	0.37	4.24	3.66	0.58	0.58
May 93	I	11.88	11.30	0.58	0.58	10.15	3.66	6.49	6.49
	II	15.23	14.28	0.95	0.95	21.61	4.16	17.45	17.45
Jun 93	I	24.08	21.99	2.09	2.09	25.37	7.63	17.74	17.74
	II	16.46	14.71	1.75	1.75	24.80	6.05	18.75	18.75
Jul 93	I	15.70	14.95	0.75	0.75	26.07	6.91	19.16	19.16
	II	16.91	16.08	0.83	0.83	103.41	99.66	3.75	3.75
Aug 93	I	18.50	17.42	1.08	1.08	5.08	3.16	1.92	1.92
	II	20.84	19.84	1.00	1.00	6.74	5.16	1.58	1.58
Sep 93	I	16.99	15.50	1.49	1.49	24.19	10.02	14.17	14.17
	II	24.16	23.00	1.16	1.16	23.49	4.74	18.75	18.75
Oct 93	I	17.24	15.66	1.58	1.58	38.37	6.91	31.42	31.42
	II	9.75	8.91	0.84	0.84	33.74	5.83	27.91	27.91
Nov 93	I	25.41	22.99	2.42	2.42	70.99	6.16	64.83	64.83
	II	17.66	14.75	2.91	2.91	49.82	8.16	41.66	41.66
Dec 93	I	15.52	15.19	0.33	0.33	36.9	3.66	33.25	33.25
	II	15.52	15.02	0.50	0.50	42.29	3.29	39.00	39.00

TABLE 7: CAR NICOBAR: ENTOMOLOGICAL SURVEY 1993

Breeding habitat	No. surveyed	Anopheles	Culex	Mix	Aedes	Total
Ponds	322	93	-	-	-	93
Drain	20	-	-	-	-	-
Wells	6250	8	183	-	-	191
Marshy area	28	12	-	-	-	12
Over head tanks	238	-	-	-	-	-
Creeks	69	55	-	-	-	55
Tanks	1127	43	2	-	-	45
Streams	15	13	-	-	-	13
Creek bed pools	13	-	-	-	-	-
Ditches	52	3	-	-	-	3
Pits	390	70	4	16	-	90
Hoof prints tyre	-	-	-	-	-	-
Tyres	5742	-	-	542	79	621
Rain water collection	34	7	4	-	-	11
Waste water collection	1231	-	305	141	-	446
Tree holes	2788	-	2	558	39	599
Intradomestic containers	7235	-	-	-	-	-
Cisterns	433	-	-	-	-	-
Canoe	1187	130	40	66	-	236
Coconut shells	3916	-	-	1202	541	1743
Peridomestic containers	6315	-	65	98	208	371
	37405	434	601	2627	867	4529

Resting Habitats: Table 9 shows that An.sundaicus was more frequently captured resting inside the copra machan (a small tightly constructed house made of bamboo and coconut leaves) than cattlesheds and human dwellings.

45 to 50% of the population rests outdoor as the collections were made from keori bushes, coconut stumps and banana tree etc.

Mosquito blood meal analysis: Mosquito blood meal of An.sundaicus were analysed by gel diffusion method from August '92 to December '93, 2270 mosquito blood meal samples were analysed. Mosquitoes were collected from copra machan, cattlesheds (Indoor), keori bushes, coconut stumps, banana trees (Outdoor) during summer and rainy season. The result of the analysis for both the season are tabulated (Tables 10 and 11). During Rainy season (June to November) out of 1166 samples, 6 samples were found positive for human (0.5%) and 11 for both

TABLE 8: CAR NICOBAR: NUMBER OF ANOPHELINE SPECIES EMERGED FROM DIFFERENT BREEDING HABITATS

Sl. No.	Species	Breeding habitats												
		Creek	Marshy area	Stream	Pond	Under ground cement	Creek bed pool	Pit	Well	Coral reaf cavi-ties	Canoe	Tree hole	Sintex tank	Mangrove
1.	An. sundiacus	2894	1723	1184	836	245	791	1039	131	432	457	0	48	1936
2.	An. barbiro-stris	0	981	2597	11	76	0	0	0	0	0	0	0	0
3.	An. barbumb-rosus	0	0	184	0	0	0	0	0	0	0	0	0	0
4.	An. insula-eflorum	0	409	288	0	0	0	0	0	0	0	0	0	0
	Total	2894	3113	4253	847	321	791	1039	131	432	457	0	48	1936

TABLE 9: CAR NICOBAR: DAY TIME RESTING HABITAT OF AN. SUNDIACUS

Structures and plants searched	No. of Search	Numbers collected						
		Female	Fed	Unfed	Semi-gravid	Gravid	Male	Total
Stilt house/hut	34	2	2	0	2	0	0	2
Unused thatched hut	43	156	109	47	22	10	44	200
Concrete house	39	0	0	0	0	0	0	0
Cocusnucifera (Coconut tree hole)	58	120	64	56	9	3	10	130
Cocusnucifera stumps	118	991	560	431	253	152	222	1213
Jamun tree	55	0	0	0	0	0	0	0
Musa paradisiaca (Banana tree)	180	187	124	63	45	30	32	219
Pandanus larun (Keori bush)	432	3863	2405	1458	1361	735	847	4710
Barringtonia speciosa	37	0	0	0	0	0	0	0
Other bushes	40	0	0	0	0	0	0	0
Copra machan	213	3950	2467	1486	1151	685	698	4648
Cattlesheds	142	1809	1252	557	561	371	363	2172
Cracks and Crevices	64	0	0	0	0	0	0	0
Concrete culvert/bridge	34	0	0	0	0	0	0	0
Total	1489	11078	6980	4098	3404	1986	2216	13294

TABLE 10: CAR NICOBAR: MOSQUITO BLOOD MEAL HOST IDENTIFICATION *

Month	Species	Collection Source	Total Samples	Result									
				Human	Pig	Cow	Goat	H/P	C/G	P/C	P/G	PCG	Others
Dec '92	An. sundaicus	CM/KB	92	1 (1.1)	38 (41.3)	8 (8.7)	-	1 (1.1)	-	1 (1.1)	-	-	43
Jan '93	"	CM/KB	96	1 (1.04)	55 (57.3)	-	2 (2.1)	-	-	-	-	2 (2.1)	34 (35.4)
Feb '93	"	CM	20	1 (5.0)	12 (60.0)	-	2 (2.1)	-	-	1 (5.0)	-	-	6 (30.0)
Feb '93	"	CS	95	1 (1.0)	70 (73.7)	-	2 (2.1)	-	-	-	1 (1.1)	-	21 (22.1)
Mar '93	"	CM/CS	96	-	54 (56.2)	3 (3.1)	1 (1.0)	-	4 (4.2)	1 (1.0)	-	-	33 (34.4)
Apr '93	"	CM/KB	95	1 (1.05)	26 (27.4)	-	-	1 (1.05)	2 (2.1)	-	-	-	65 (68.4)
May '93	"	KB	96	1 (1.04)	67 (69.4)	3 (3.1)	2 (2.1)	-	5 (5.2)	-	-	-	18 (18.7)
Dec '93	"	CS/CM	264	2 (.75)	117 (44.31)	108 (40.9)	-	-	-	-	-	-	37 (14.0)
Jan '94	"	KB/CM	250	-	204 (81.6)	14 (5.6)	-	-	-	-	-	-	32 (12.8)
			1104	8 (0.7)	643 (58.2)	136 (12.3)	9 (0.8)	2 (0.2)	11 (1.0)	3 (0.3)	1 (0.1)	2 (0.2)	289 (26.2)

* - Summer season collection; CM - Copra machan; KB - Keori bushes; Figures in parentheses shows percentage

TABLE 11: CAR NICOBAR: MOSQUITO BLOOD MEAL HOST IDENTIFICATION *

Month	Species	Collection Source	Total samples	Result									
				Human	Pig	Cow	Goat	H/P	C/G	P/C	P/G	PCG	Others
Aug'92	An. sun.	CS/UR	94	1 (1.06)	53 (56.4)	4 (4.2)	6 (6.4)	3 (3.2)	2 (2.1)	-	-	-	25 (26.6)
Nov'92	"	CM/KB	83	49 (59.0)	3 (3.6)	-	-	-	1 (1.2)	1 (1.2)	-	-	29 (35.0)
Jun'93	"	KB	121	-	65 (53.7)	3 (2.5)	-	-	-	2 (1.05)	-	-	51 (42.1)
Jun'93	"	KB/CM	89	3 (34.8)	31 (34.8)	2 (2.24)	1 (1.12)	3 (3.4)	3 (3.4)	-	-	1 (1.22)	45 (50.6)
Jun'93	"	UR/LT/KB	98	1 (1.02)	65 (66.3)	4 (4.1)	1 (1.02)	-	-	6 (6.1)	-	-	21 (21.4)
Jun'93	"	KB	77	-	38 (9.3)	-	-	-	-	2 (2.6)	-	-	36 (46.7)
Aug'93	"	KB/CM/UR	96	-	84 (87.5)	-	-	-	-	-	-	-	12 (12.5)
Sep'93	"	CM/KB	88	-	54 (61.4)	1 (1.13)	2 (2.3)	2 (2.3)	-	-	1 (1.13)	-	28 (31.8)
Oct'93	"	CM/KB	176	1	128 (0.56)	-	1 (72.7)	1 (0.56)	-	-	1 (0.56)	-	44 (25.0)
Nov'93	"	CS/CM/KB	244	-	179 (73.4)	29 (11.9)	-	-	2 (0.81)	1 (0.40)	-	-	33 (13.5)
			1166	746	46	12	11	7	11	11	2	1	324

* Rainy Season Collection; An. sun. - An. sundaicus; Figures in parentheses shows percentage

human and pig (0.9%), 746 samples were positive for pig (69.0%) and 46 samples positive for cow (39%). During summer season (December to May) total 1104 blood meal samples were analysed out of which 8 samples were positive for human (07%) and 2 samples for both human and pig (0.2%). For pig 643 (58.2%) samples were found positive and for bovine 136 (12.3%) found positive. The anthropophilic index for An.sundaicus during the rainy season was 1.46 (including human and pig mixed samples). In comparison to this, the Anthropophilic index during summer season was 0.9 (including human and pig mixed samples). The results revealed that An.sundaicus is more zoophilic (attracted towards pig) than anthropophilic (man and other).

Biocide: The larvicidal activity of Bacillus sphaericus (Spherix) was evaluated against An.sundaicus larvae in different mosquito breeding habitiats like marshy area, mangroves area, coconut garden pools and in creeks. The Biocide was applied @ 1 gm/sq m surface area of these habitats. In general, the Bacillus spray was re-applied on second week, however the appearence of III and IV instar larvae was the criteria for the re-spray.

Marshy area

Marshy area with heavy algal growth: Bacillus sphaericus spraying in this habitat produced 95.4% reduction of III and IV instar An.sundaicus larvae in 48 hours, however it declined to 84.5% on day 7. This decline was due to the presence of putrifying algal mass which keeps mosquito larvae away from the exposure of Bacillus and also provides shelter to mosquito larvae from the exposure to the toxin. After re-spray on day 7, day 21 and day 35 the per cent reduction of larval mortality was between 96 to 100% (Fig. 1 a).

Marshy area with thick algal mat on the surface of water: In this habitat the larval mortality was 98.5% in 48 hour and 100% reduction was maintained up to 4th weeks (Fig. 1 b). This effectiveness of biocide on larval mortality was due to the filamentous algal mat on the entire surface of water which makes the mosquito larvae more vulnerable to the exposure of Bacillus.

Marshy area with sparse vegetation: In marshy area with sparse vegetation the larval mortality after Biocide application maintained 93 to 96 per cent reduction from 48 h to 21 day. After the 3rd round of biocide spray the larval mortality was maintained upto 100% (Fig. 1 c).

Marshy area with grassy margin: The biocide is highly effective in the marshy areas with grassy margin. It shows 100% reduction of III and IV instar larvae in 48 h and it was maintained till 3rd week (Fig. 1 d).

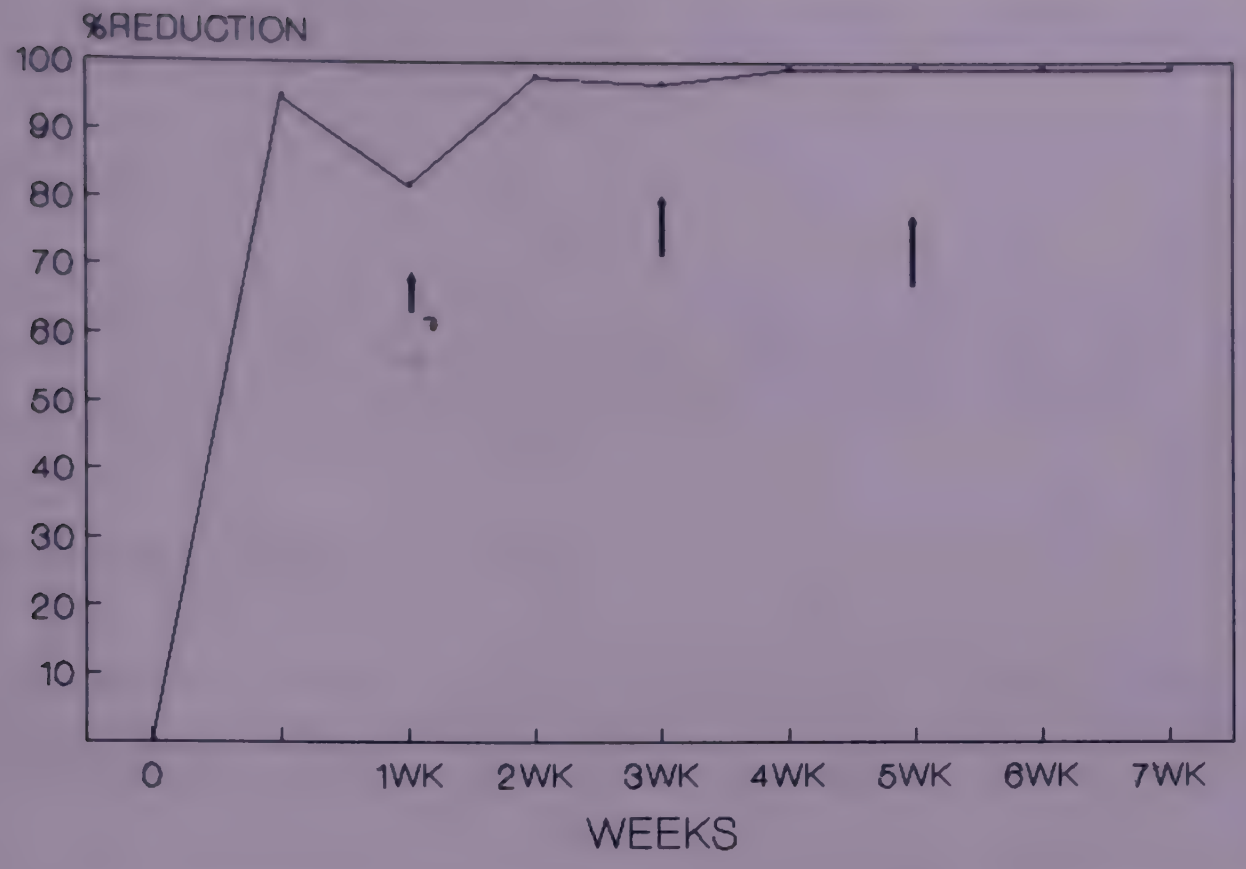


Fig. 1a: Car Nicobar: Impact of Spherix on mosquito breeding in marshy area with heavy algal growth

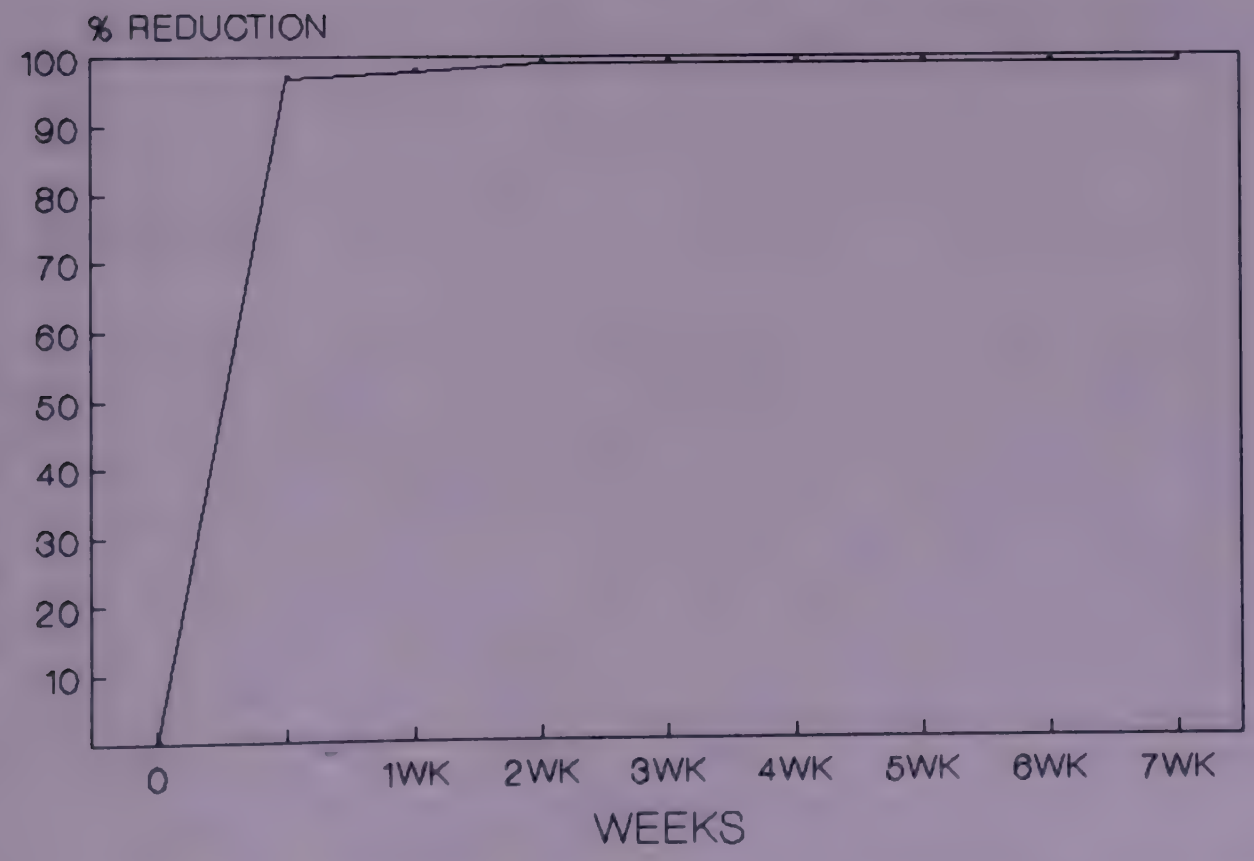


Fig. 1b: Car Nicobar: Impact of Spherix on mosquito breeding in marshy area with thick algal mat on the surface of water

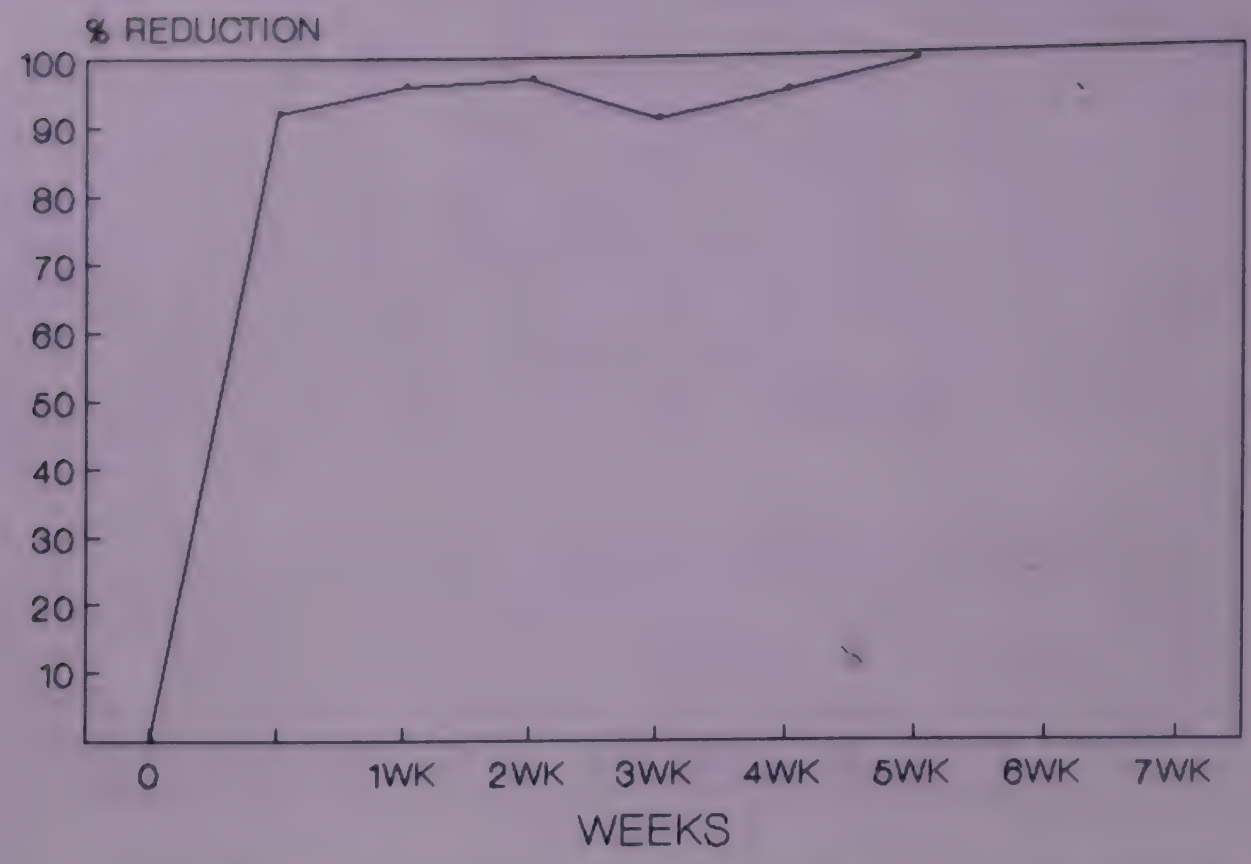


Fig. 1c: Car Nicobar: Impact of Spherix on mosquito breeding in marshy area with sparse vegetation

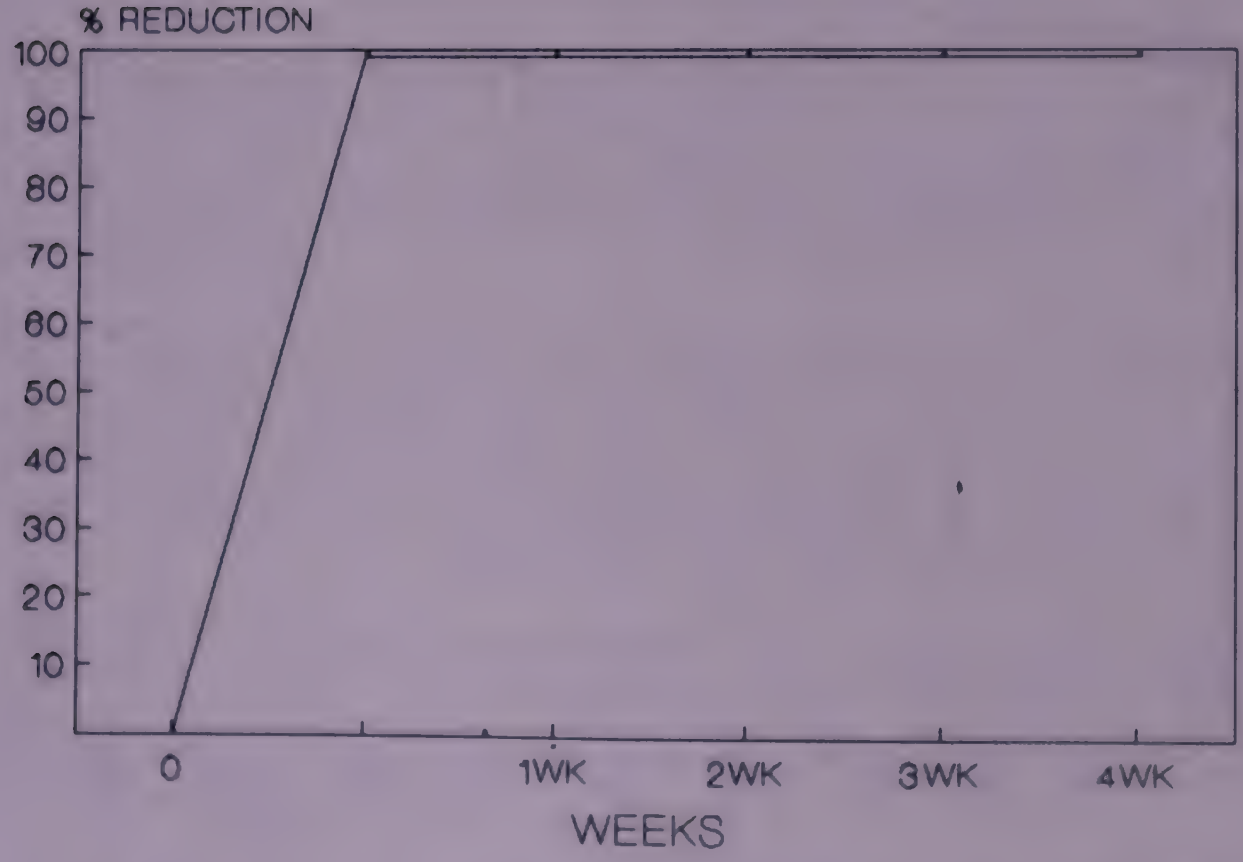


Fig. 1d: Car Nicobar: Impact of Spherix on mosquito breeding in marshy area with grassy margin

In all these habitats the salinity of water was recorded below 1 gm/l and pH was alkaline (8.0).

Mangrove area

Mangrove pools: The impact of Biocide in mangrove pools was excellent. After 48 h the larval mortality was 100% and it was maintained till 5th week . The salinity and the pH of water was 7.8 gm/l and 8.0 respectively (Fig. 2).

Coconut garden pools

In coconut garden pools the impact of biocide was 100% from 48 h and it was maintained upto 3rd week (Fig. 3). The salinity and pH of water was 0.6 gm/l and 8.0 respectively.

Creeks

The biocide was highly effective in creeks with vegetation and without vegetation. It produced 100% reduction of III and IV instar larvae in 48 h onwards till 5th week (Fig. 4). The salinity of water was 10 and 1.6 gm/l in creek with vegetation and creeks without vegetation respectively. The pH of water was 8.0 in both the habitats.

Health Education

In the year 1993 due importance has been given to health education programme in Car Nicobar Island. The aim of the programme is to make people aware of the malaria situation and personal protection methods. The aim was achieved by arranging a series of exhibition, health camps, group meetings, door-to-door visits, writing slogans on the walls and distribution of health educations pamphlets (Table 12). All the villagers were taught to control the mosquito breeding at breeding sites. As a result of these ongoing activities the villagers started coming forward for community participation. Villagers collected larvivorous fishes to release in their wells and tanks from the Malaria Research Centre. One day seminar on bioenvironmental control of malaria was organized in Campbell Bay. It is worthwhile to mention that in this year intra-sectoral cooperation were rendered by various institutions like District Administration, Trible Council, Andaman Public Works Department (A.P.W.D.) Civil Hospital, Defence and Education Department etc. (Table 13).

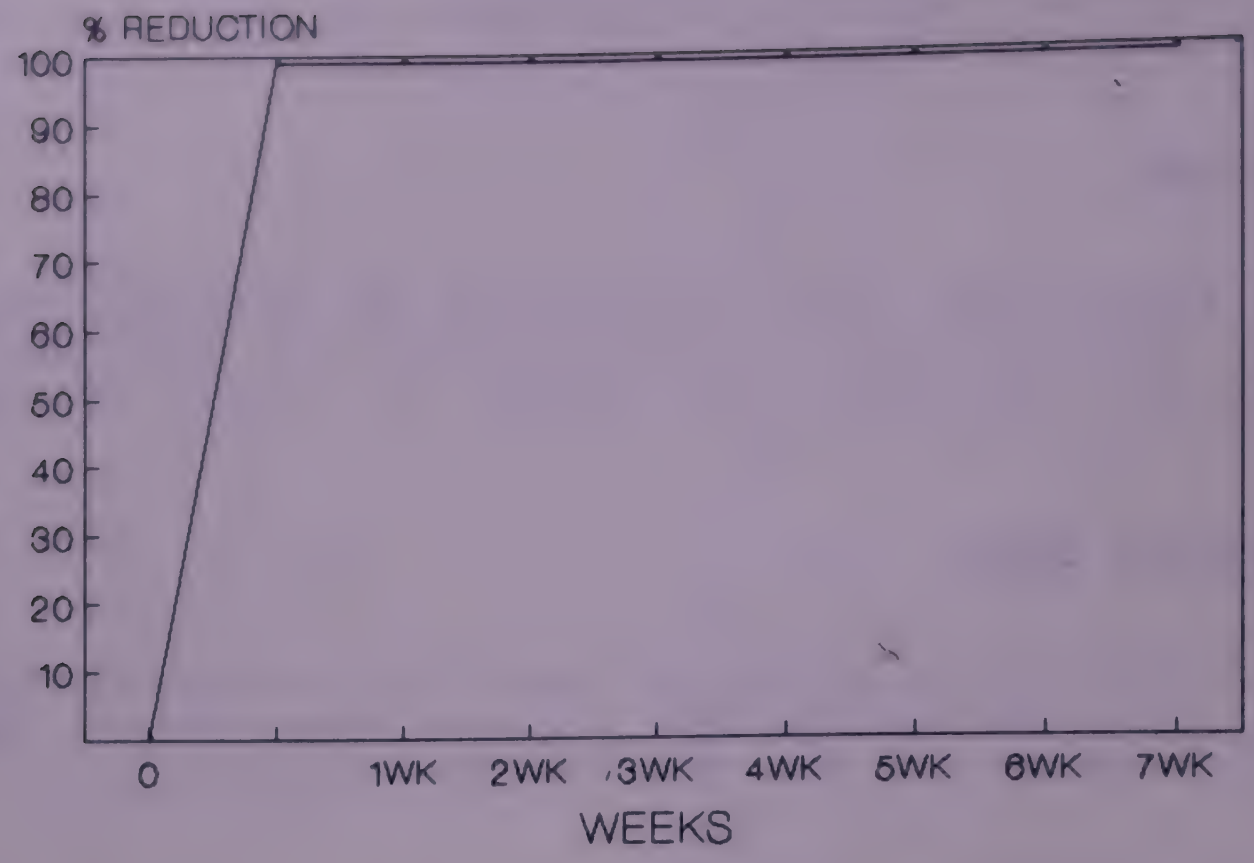


Fig. 2: Car Nicobar: Impact of Spherix on mosquito breeding in Mangrove pools

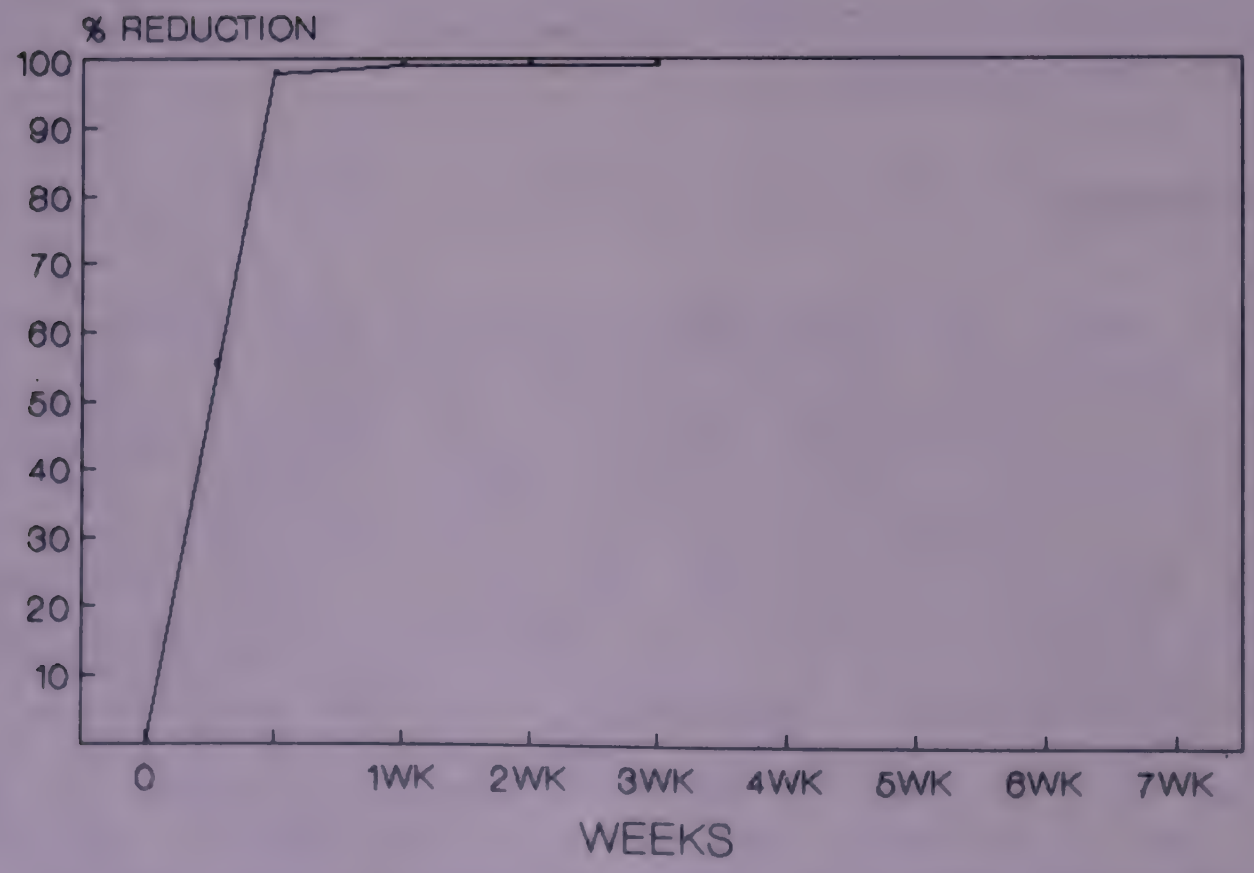


Fig. 3: Car Nicobar: Impact of Spherix on mosquito breeding in Coconut garden pools

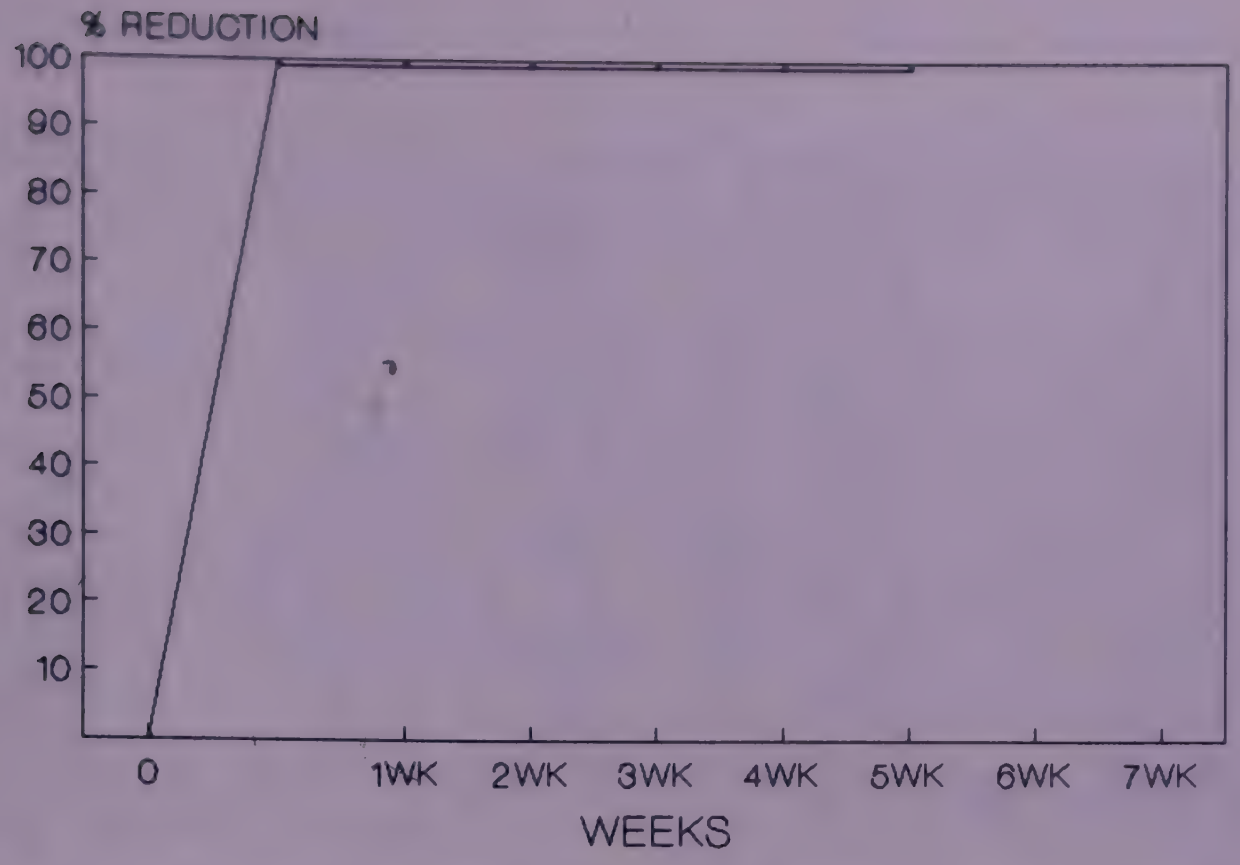


Fig. 4: Car Nicobar: Impact of Spherix on mosquito breeding in creeks

TABLE 12: CAR NICOBAR: HEALTH EDUCATION PROGRAMME UNDERTAKEN

Programme	Event in 1993	No. of people attended
Exhibitions/Health Camps		
- In villages	3	3115
- In labour camps	1	523
- In school	2	2539
total	6	6177
Group meetings		
- In villages	297	4648
- In labour camps	78	356
Total	375	5004
Door-to- door visits		
- At construction sites	'17	1103
- At villages	242	848
Total	259	1951
No. of health education pamphlets distributed	2115	

TABLE 13: CAR NICOBAR: INTERSECTORAL COOPERATION RENDERED BY VARIOUS INSTITUTIONS

Agency/Department	Activity	Remarks
District Administration	Social forestry Environmental modification through District Rural Development Agency (DRDA), Jawahar Rozgar Yozna(JRY) etc. Construction of tanks for larvivorous fishes	Very much cooperative and doing the various works for malaria control activities
Tribal Council	Environment in JRY, DRDA Environmental management	This office helped in mobolising villagers to cooperate with MRC for malaria and mosquito control
Andaman Public Works Department (A.P.W.D.)	Construction of drains Construction of sluice gate at creeks	They provided full cooperation in construction activities
Civil Hospital	Health education, Training of staff on bioenvironmental strategy, Malaria and Filaria survey	They always cooperate in all malaria control activities and help in proper management and treatment of malaria cases
Defence	Implementation of bioenvironmental strategy in different areas Health education to defence personnel	Showed keen interest in collection of larvivorous fishes like Gambusia and Oreochromis and introduced them in their wells, tanks
Education department	Lectures on bioenvironmental control of malaria	-
Schools	Health education to the students to create awareness about malaria and mosquito control	The teachers are interested and were involved in environmental modifications with the help of school children
Construction sites	Using Gambusia in wells to check breeding and earth work	They always helped in filling work to prevent mosquito menace

Epidemiological Results:

Since the effective implementation of bioenvironmental control strategy there has been drastic decline in the malaria incidence as seen in the linear diagram (Table 1, Fig 5).

In the year 1992 there were 636 malaria cases with 276 falciparum malaria as detected by the NMEP unit located at Civil Hospital, Car Nicobar. In 1993 total malaria cases came down to only 340 with 153 falciparum cases. In comparison to baseline date of 1989 (the year of inception of the field station) the reduction was by 92.1% and 93.5% respectively. However the indoor residual spray by NMEP was not interrupted though the room/HD coverage during these years were less (54-70%) in comparison to previous years (90-84%). Weather conditions of the year 1993 are given in Table 14.

The API in 1993 was only 16.91 which is the lowest recorded API of Car Nicobar Island.

Filariasis survey in Nicobar group of Islands

Filariasis survey was carried out in Nicobar group of Islands (Nicobar district). The Islands are Car Nicobar, Chowra

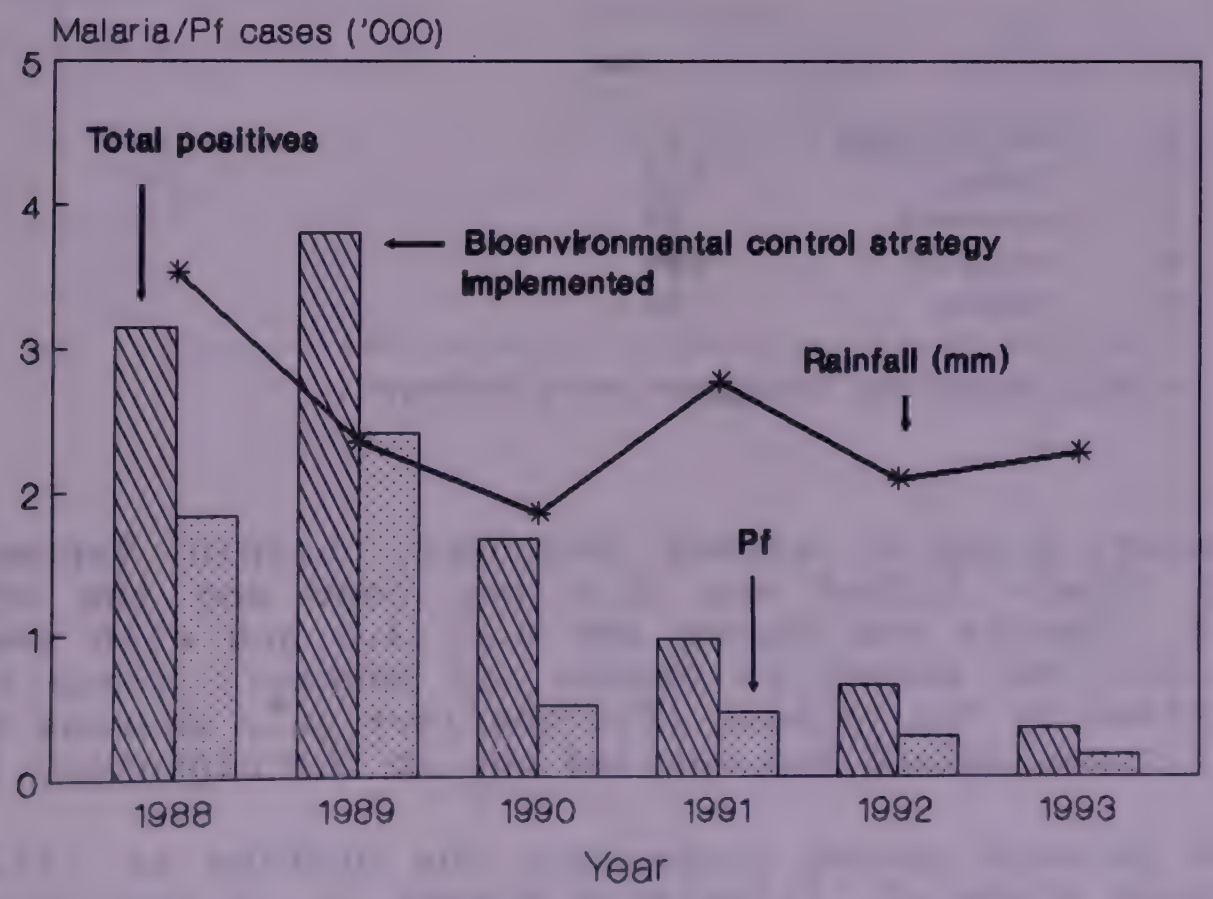


Fig. 5: Car Nicobar: Impact of bioenvironmental control strategy on total malaria and Pf cases

TABLE 14: CAR NICOBAR: METEOROLOGICAL DATA

Month 1993	Temperature c			Relative huminidy (%)		Rainfall	
	Max.	Min.	Mean	Max	Min.	Actual (mm)	No of rainy days
Jan	32.6	18.5	25.55	95.0	54.0	23.6	2
Feb	32.5	17.7	25.1	82.0	54.0	-	-
Mar	34.5	21.5	28.0	80.0	66.0	29.2	5
Apr	34.6	22.2	28.4	83.0	61.0	89.5	6
May	34.0	23.8	28.9	98.0	64.0	345.4	22
Jun	32.6	23.3	27.95	92.0	68.0	197.2	17
Jul	32.6	23.4	28.0	98.0	71.0	298.6	24
Aug	32.2	23.0	27.0	87.0	69.0	115.3	22
Sep	31.0	22.8	26.9	100.0	71.0	295.6	24
Oct	32.6	22.5	27.55	97.0	74.0	424.2	21
Nov	32.4	22.0	27.2	96.0	71.0	263.6	15
Dec	32.4	20.0	26.2	98.0	50.0	174.6	8

TABLE 15: CAR NICOBAR: FILARIA INCIDENCE

Sno.	Island surveyed	Blood smear collected examined	No. of micro-filaria	Microfilaria (mf) rate 9%
1.	Car Nicobar *	141	12	8.6
2.	Chowra	812	200	25.0
3.	Nancowry	82	3	3.6
4.	Champin	154	7	4.5
5.	Tapong	48	2	4.16

* Only migratory labourers were surveyed.

and Nancowry group of Islands (Nancowry, Champin, Tapong). The mf rate in Chowra Island was 25.0 per cent and the mf rate in Nancowry, Champin and Tapong was 3.6, 4.5 and 4.16 respectively (Table 15). The survey in Chowra and Nancowry group of Islands was confined to the tribals (Nicrobaries) only whereas the survey in Car Nicobar Island was carried out in the migratory labourers.

The present survey highlights the problem of filariasis in the Nicobar district. Filariasis survey is in progress to asses the filaria incidence in the Nicobar group of Islands.

BIOLOGICAL MATERIAL BEING MAINTAINED AT MRC, FIELD STATION, CAR NICOBAR.

Mosquito Strains

An.sundaicus

Wild strain

Fresh water forms

i) Malacca
ii) Arong
iii) Auckchong

Brackish water forms

i) Kimius

Morphological mutants

i) Green larvae
ii) Brown larvae

Wild strain

i) Culex quinquefasciatus

Wild strain

Aedes aegypti

i) Chowra Island
ii) Car Nicobar Island

Wild strain

Aedes albopictus

i) Chowra Island
ii) Car Nicobar Island

Wild strain

Toxorhynchites splendens

Car Nicobar Island

Biological control agents

Fishes

i) Aplocheilus panchax
ii) Ophiocara aporos
iii) Gambusia affinis
iv) Oreochromis mossambica

(XIII) BANGALORE, KARNATAKA

The revised strategy of malaria control in Karnataka state has been under implementation since 1991-92. This revised strategy is primarily based on malariogenic stratification undertaken by the Directorate of National Malaria Eradication Programme taking into the consideration six sensitive but quantifiable epidemiological parameters viz. topography, average annual rainfall, vector(s) species, average annual parasite incidence (API) for the last five years, epidemic potential and vulnerability. The Karnataka state was stratified into five strata and appropriate control measures were suggested for each stratum. As part of the control measures under revised malaria control strategy it was envisaged to introduce bioenvironmental methods in Karnataka. To begin with a decision was taken by the Health Directorate, Government of Karnataka to implement bio-environmental control strategy initially in the problem PHCs of six districts (Table 1, Fig. 1) in a phased manner during VIII plan.

On the request of Government of Karnataka a field station of Malaria Research Centre was opened in Bangalore city in October 1992 which became operational in January 1993. The primary objectives of this field station are:

1. To prepare action plan for implementation of bio-environmental methods of malaria control in the problem PHCs as identified by malariogenic stratification.

The preparation of action plan involves (a) extensive Geographical Reconnaissance (GR) of mosquito breeding habitats in malaria prone villages; (b) identifying suitable

TABLE 1: BANGALORE: NUMBER OF PHCS TO BE BROUGHT UNDER BIO-ENVIRONMENTAL CONTROL STRATEGY DURING VIII PLAN IN KARNATAKA STATE

S.No.	District	No. of PHCs under stratum			Total
		III	IV	V	
1.	Kolar	2	1	5	8
2.	Tumkur	4	3	5	12
3.	Chitradurga	3	4	5	12
4.	Bijapur	16	10	5	31
5.	Gulbarga	7	3	7	17
6.	Raichur	14	2	3	19
	Total	46	23	30	99

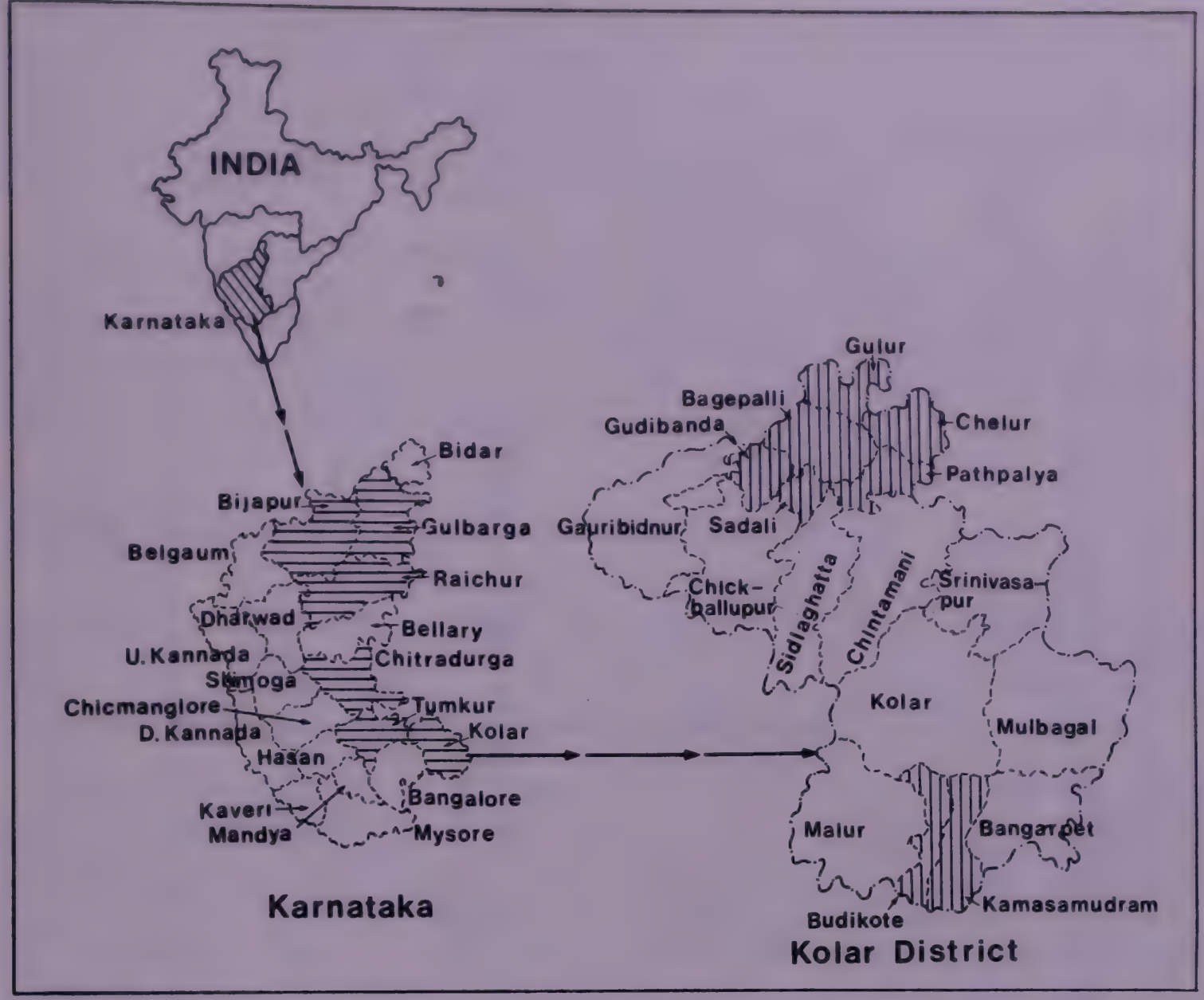


Fig. 1: Bangalore: Malaria problem districts in Karnataka state for implementation of bioenvironmental control strategy during VIII plan and district Kolar map showing malaria problem P.H.Cs.

bioenvironmental intervention strategies including minor engineering methods with designs and budget estimates and, (c) identifying various collaborating agencies for actual implementation of intervention work.

2. Transfer of technology of bioenvironmental methods of malaria control to State Health Department particularly, setting up of larvivorous fish hatcheries along with handling and usage of larvivorous fishes.

Working arrangements

To monitor the progress following two high power committee were set up by Government of Karnataka i) Working Committee,

TABLE 2: BANGALORE: EPIDEMIOLOGICAL DATA OF DISTRICT KOLAR

Year	Population	BSE	Positive for			ABER	API	SPR	SfR
			Pv	Pf	Total				
1988	19,99,412	4,13,813	794	1,487	2,281	20.7	1.1	0.6	0.4
1989	19,99,412	4,19,653	3,499	5,881	9,380	20.9	4.7	2.2	1.4
1990	20,01,015	4,25,670	11,573	12,205	23,778	21.2	11.9	5.6	2.9
1991	20,51,729	3,64,883	8,689	2,155	10,844	17.2	5.1	3.0	0.6
1992	20,51,729	4,19,308	22,412	7,174	29,586	19.7	14.3	7.3	1.8
1993*	22,11,000	3,55,898	18,060	3,665	21,725	16.1	9.8	6.1	1.03

* - Upto November 1993

TABLE 3: BANGALORE: STATUS OF GEOGRAPHICAL RECONNAISSANCE IN DISTRICT KOLAR

S.No.	Name of PHC	Stratum	Total villages in PHC	Problem villages surveyed for GR
1.	Kamasamudram	IV	141	89
2.	Budikote	III	89	26
3.	Sadali	III	83	24

Chaired by Secretary, Health; Heads of different departments e.g., PWD, PHED, Forest, Fisheries, Local Self Governments are members while Joint Director (Malaria & Filaria) is the member secretary, ii) Administrative Committee, Chaired by chief secretary, Secretaries of different departments are members while Health Secretary is the member secretary.

Action plans prepared by Malaria Research Centre to be examined first by Working committee and later on by administrative committee which after allocation of funds to the concerned departments to give final approval for the implementation of the action plan on bioenvironmental methods of malaria control in the concerned PHCs/district.

Progress of work done during 1993

Malaria Research Centre has started work in district Kolar, highly malarious district of Karnataka (Table 2) contributing nearly 36% of the total malaria cases and 43% of the total Pf incidence reported from the state annually.

Kolar district consists of 3,338 villages in 11 taluks having a total area of 8223 sq km. Topographically it is having undulating plain terrain with hilly and little forested areas. The district receives low rainfall with an average rainfall of about 600 mm. Main occupation is agriculture and sericulture has been taken up extensively, as a cottage industry in the entire district.

There are 60 PHC's in Kolar district falling in stratum I (32 PHCs), stratum II (20 PHCs), stratum III (2 PHCs), stratum IV (1 PHC) and stratum V (5 PHCs). The 8 PHCs (Stratum III, IV and V) has problematic situation for malaria and contribute to nearly 90% malaria incidence of the district. Out of 8 problem PHCs, 5 of stratum V are bordering Andhra Pradesh and 1 PHC each of stratum IV (PHC Kamasamundram) and stratum III (PHC Budikote) are bordering Tamil Nadu. (Fig. 1).

Geographical Reconnaissance

Geographical reconnaissance has been completed in 3 PHCs (Table 3) and action plans have been submitted to the Directorate of Health Services, Government of Karnataka for further action. GR of PHC Gudibanda (Stratum V) is in progress.

GR revealed the following types of breeding sites in the PHCs surveyed so far in the district.

Major breeding sites - Irrigation tanks, streams and irrigation wells

Minor breeding sites - Irrigation field channels, drinking water draw wells, irrigation pits, borrow pits, Seepages from tanks and paddy fields

Irrigation tanks: Kolar is also known as 'district of tanks' as there are 4479 tanks in this district. Tanks, a minor irrigation device, are small reservoirs built by constructing earthen dams in the basin of the valleys on streams for community irrigation. The characteristic feature of these tanks is that they are built in series in such a way that the boundary of the upper tank almost matches with the peripheral boundary of the lower tank and there is practically a hydraulic continuity. Majority of the tanks are seasonal and retain water till February/March only. Only a few tanks are perennial. Most of the tanks are situated in the vicinity of the villages. Usually mosquito breeding occurs on the grassy margins of the impounded water body of the tank. Moreover, receding water results in creation of numerous pools and pits in the tank bed which become highly conducive for mosquito breeding.

Streams: Because of the general undulating plain terrain of the area several small to medium size minor seasonal streams are usually present which carry rain water from the upper hilly areas to the tanks present in the lower basin and also from one tank to another. These minor streams ultimately join a major stream which is usually perennial and greater contributory factor for mosquito breeding. Some of the major perennial streams have characteristic bed with rocky outcrops and large number of boulders which afford creation of steam bed pools in the depressions bounded by boulders and rocky outcrops when the monsoon flow ceases particularly in dry months (January - June). The supply of water due to seepages, subsurface percolation from perennial tank(s), return flow of surface irrigation water from paddy fields, canals maintain these pools by and large perennial. These stream bed pools provide favourable breeding ground for An. culicifacies which is the principal malaria vector. Moreover, between October-January these perennial streams due to slow movement support the breeding of An. fluviatilis, another vector present in the district.

Irrigation Wells: Wells are the chief irrigation source in Kolar district. Usually these are open dug wells (30-40 feet deep) and available in large numbers in every village. The sub-soil water collected in these wells is lifted by electrical (motor) or mechanical (bullocks) means for irrigation purposes. In villages where ground water level has depleted appreciably due to its extensive tapping by bore-wells (tubewells) some of these open dug wells become dry in summer months, otherwise, they are, by

and large, perennial water bodies and vector mosquitoes breed profusely throughout the year.

Drinking water wells: The draw wells, once used for drinking water, have now become disused or at best rendered semi-used because of the availability of piped water supply in almost all villages. The contribution of draw wells in vector mosquito production is relatively less.

Irrigation channels: Usually one or two small earthen field channels come out of all minor tanks and feed to the nearby fields within the boundary area of the tank. Depending on the amount and timing of the rains and consequently water level in the tanks these earthen channels run mainly from July/August to December and also in February-March chiefly to irrigate paddy. However, from major perennial tanks pucca stone pitched canals come out. In addition, in some places 'pick up channels' have been provided in major perennial streams by making use of the gradient and putting masonary curtains in the stream bed to collect upstream water and divert it to nearby village.

Problems associated with the irrigation channels resulting in mosquito breeding, in general, are (a) embankment with heavy vegetation and, (b) leakage/seepage of water from the embankments to low lands.

Irrigation pits: Irrigation pits are small balancing ponds constructed on earthen platform in the fields by a few farmers to store water from irrigation wells/borewells when power is available and to use this stored water in the times of non-availability of power for pumping. Construction of Irrigation pits provide necessary head for water flow through pipes or channels to the distant fields. Water stagnates in these irrigation pits when not in use and provide breeding site for mosquitoes.

Borrow pits: These are essentially temporary mosquito breeding sites associated with rainy season and mis-management of wasteland.

Tank seepages: Amount of water seepages from tank to the nearby low-lying areas is directly associated with the water level in the tank. In seasonal tanks the seepages also stop after February/March. However, in perennial tanks seepages may continue throughout the year. In almost all tank seepages paddy is grown by the villagers.

Paddy fields: Paddy is mainly taken as a kharif crop(July-December) in Kolar district. Summer paddy crop is also taken provided, north-east monsoon rains are good and tanks have sufficient water. Otherwise summer paddy is grown by only those farmers having their own irrigation facilities. Paddy fields with

TABLE 4: BANGALORE: ANOPHELINE'S BREEDING SPECTRUM IN DISTRICT KOLAR

S.No.	Species emerged	Breeding sites							
		Tanks	Streams	Wells	Irrigation channels	Irrigation pits	Borrow pits	Seepages	Paddy fields
1.	An. culicifacies	++	+++	+++	++	++	+	+	+
2.	An. fluviatilis	+	++	+	-	-	-	-	-
3.	An. stephensi	-	-	++	-	-	+	+	-
4.	An. annularis	+++	+++	+	+	++	+	+	++
5.	An. nigerrimus	++	++	+	+	+	+	++	+++
6.	An. barbirostris	+	+	+++	+	+	+	++	++
7.	An. pallidus	+++	+	+	+	+	+	+	++
8.	An. karwari	-	+	-	+	-	-	-	-
9.	An. subpictus	+++	++	+	+	++	+++	++	+++
10.	An. pseudojamesi	+	+	+	-	+	+	+	+
11.	An. vagus	+	+	+	-	+	+	+	+
12.	An. varuna	+	-	++	++	-	-	-	-
13.	An. tessellatus	-	+	++	-	+	-	-	-
14.	An. peditaeniatus	-	-	-	-	-	-	-	+
15.	An. jeyporiensis	-	-	+	-	-	-	-	-
16.	An. aconitus	-	-	+	-	-	-	-	-
17.	An. moghulensis	-	-	+	-	-	-	-	-

continuous submergence irrigation practice provide favourable breeding grounds for mosquitoes.

Anopheline breeding spectrum

Table 4 gives the results of anopheline emergence study carried out habitatwise in the three PHCs surveyed so far in district Kolar.

Vector contribution by different breeding sites

At the time of carrying out GR larval surveys were also conducted from 30-40% breeding sites of each category in each village and collected anopheline larvae were reared till emergence for identification. Per cent vector contribution of a breeding site was calculated as the proportion of vector mosquitoes emerged from that particular breeding site out of total vector's emergence from all breeding sites in a PHC (Table 5).

It is apparent that streams, particularly perennial streams, and irrigation wells are the two major vector contributing habitats in district Kolar and in order to control malaria it is extremely important to control vector breeding in these two vital breeding sites along with tanks. Studies are being contemplanted to define the exact role these two major breeding sites in disseminating malaria in district Kolar.

TABLE 5: BANGALORE: PER CENT VECTOR CONTRIBUTION BY DIFFERENT BREEDING SITES IN VARIOUS PHCS

S.No.	Breeding site	PHC Kamasamudram (Stratum IV)	PHC Budikote (Stratum III)	PHC Sadali (Stratum III)
1.	Tanks	8.8	8.6	8.6
2.	Streams	42.3	27.3	26.2
3.	Irrigation wells	35.5	43.1	42.3
4.	Drinking water draw wells	7.0	2.6	5.2
5.	Irrigation channels	0.4*	6.8	6.6
6.	Irrigation pits	0.3*	4.1	5.4
7.	Borrow pits	2.9	2.7	3.5
8.	Seepages	3.1	3.5	2.4
9.	Paddy fields	0.0*	1.5	0.0 **

* Mostly found dry at the time of survey; ** Paddy fields largely absent

Training in bioenvironmental methods of malaria control to PHC staff

Two days orientation exercise (two Nos) in bioenvironmental methods of malaria control were organised for the benefit of field staff of PHC Kamasamundram and PHC Budikote by MRC. These courses were attended by 47 peripheral staff of the two PHCs. Besides giving theoretical knowledge on the alternate strategy of malaria control with the help of lectures, live material audio-visual aids and field demonstrations were also given to the participants regarding a) handling of larvivorous fishes b) collection, transportation and release of larvivorous fishes in different breeding sites and c) establishment and maintenance of larvivorous fish stocks.

Consequently PHC Kamasamundram staff became active and have established 10 local stocks of guppy in different villages and targeting to release guppy fishes in all malaria prone villages in PHC Kamasamundram.

12.3 SALIENT FEATURES OF THE REVIEW MEETING CARRIED OUT BY THE NODAL DEPARTMENT/MINISTRY

12.3.1 MINUTES OF THE MEETING OF EXECUTIVE COMMITTEE MEETING OF THE S&T PROJECT ON THE INTEGRATED VECTOR CONTROL OF MALARIA, FILARIA AND OTHER VECTOR BORNE DISEASES HELD AT MALARIA RESEARCH CENTRE, 20 MADHUBAN, DELHI ON AUGUST 2ND, 3RD, 1993.

Following members were present:

1. Dr. V.P. Sharma, Chairman
2. Dr. V.K. Dua, Hardwar
3. Dr. S.K. Sharma, Hardwar
4. Dr. Neeru Singh, Jabalpur
5. Dr. O.P. Singh, Jabalpur
6. Dr. R.S. Yadav, Rourkela
7. Dr. S.K. Chand, Rourkela
8. Dr. S.N. Prasad, Shahjahanpur
9. Dr. S.N. Sharma, Shahjahanpur
10. Dr. G.D.P. Dutta, Shahjahanpur
11. Sh. P.K. Pujara, Nadiad
12. Dr. Anil Prakash, Bangalore
13. Dr. Ashwini Kumar, Goa
14. Dr. M.K. Das, Goa
15. Dr. B. Shahi, Allahabad
16. Dr. I. Kar, Madras
17. Dr. Aruna Srivastava, Delhi
18. Dr. T. Adak (Member Secretary), Delhi

Dr. D.S. Choudhary, Dr. N.L. Kalra and Dr. N.N. Singh (Consultant), Dr. Pathak (Pant Nagar, University), Dr. M.A. Ansari, Dr. S,K, Subbarao, Dr. Lalitha Kabilan, Dr. Arti Roy, Dr. M.S. Malhotra, Dr. R.C. Dhiman, Dr. C.R. Pillai, Dr. C.P. Batra, Dr. P.K. Mittal and Dr. B.N. Nagpal also attended the meeting.

Chairman welcomed the committee members and briefly reviewed the progress of S&T project. Committee members were informed that at some field stations the work on bioenvironmental control is in progress while at others demonstration work has been terminated and new projects have been launched. Broadly the following projects were selected for multi-centric trials.

1. Studies on the impact of bio-larvicides on mosquito breeding, adult mosquito population and on transmission of malaria and filariasis.

2. Studies on the agro-ecosystem as related to the breeding of various vectors and methods to control mosquito breeding.

3. Field trials with the neem oil (Azadirachta indica) as a mosquito repellent.

4. Studies on Narmada project in M.P. and Sardar Sarovar project in Gujarat.

5. Insecticide impregnated bed nets to control malaria.

In addition to the above projects at many field stations studies were taken up on P. falciparum resistance, bionomics of vectors and dynamics of malaria transmission. Malaria clinics helped communities in the early detection and treatment of malaria, development of new biological control methods such as the fungi, remote sensing and geographical information system. Several workshops were organized on environmental methods of mosquito control and management of serious and complicated malaria.

Two days were spent on detailed presentation of field work, future line of research followed by discussions on each topic. There were special presentations on the following subjects:

1. Studies on Remote Sensing to map mosquito breeding habitats. - (Dr. M.A. Ansari, Dr. B.N. Nagpal, Dr. R.C. Dhiman).

2. Studies on Geographic Information System (GIS). - (Dr. M.S. Malhotra)

3. New chemical method for detection of resistance in malarial parasite. - (Dr. V.K. Dua)

4. Activities of Malaria Parasite Bank - (Dr. C.R. Pillai)

5. Exhibition on malaria - (Dr. M.S. Malhotra)

6. Video films on Blood slide preparation, parasite identification, chemotherapy and life cycle of malaria parasites - (Mr. T.R. Rao)

Towards the end of the second day administrative and financial matters were discussed.

The following decisions were taken.

1. A protocol on the epidemic investigations was circulated to all the field stations. It was proposed that in future malaria epidemic investigations should be carried out as per

the protocol and where ever there were reports of epidemic, MRC field stations should carry out detailed investigations.

2. A socio-economic study protocol is being provided to all the S&T project staff. Since socio-economic aspects as related to malaria have not been documented, scientists should try to study this aspect at a few sites following the protocol prepared for this purpose.

3. The transfer of technology project in Bangalore should provide village-wise detailed designs, identify collaborating agencies with funding provisions, work out budget for each activity and prepare an action plan for the state govt. This work may be done district wise in consultation with the health deptt. and final document handed over to Director Health Services for their follow up action. The team can move to new district for a similar action plan. An engineer may be hired on priority basis to help in the preparation of designs and budget estimates as also feasible intervention strategies. Action: Dr. Anil Prakash.

4. A stock of 1 mt. ton EPS beads would be maintained at MRC for various field stations. Action: Dr. T. Adak.

5. Biocide work will continue uninterrupted at all the field stations identified for this purpose. Because of problems in the initial distribution of biocide, the following quantities of biocides (Bactoculicide) will be re-distributed from Shahjahanpur. Action: Dr. R.N. Prasad.

100 kg to Haldwani

100 kg to Mandla

500 kg to Hardwar

500 kg to Goa

500 kg to Delhi

Immediate action may be taken to transport the above quantity of bactoculicide.

"Spherix" would be transferred from Mandla to Delhi and other field stations. Action: Dr. Neeru Singh, Dr. T. Adak.

6. WHO test kits to test P. falciparum sensitivity against chloroquine for about 200 cases may be provided to Dr. V.K. Dua, Hardwar field station from the supplies expected to be received by MRC, HQs. Action: Dr. S.K. Subbarao/ Dr. T. Adak.

7. Field station staff will take action on i) the early publication of research findings ii) provide article for Malaria Patrika iii) prepare a brochure of the highlights of field work particularly of the finished research and iv) continue to transfer the know how on malaria control to the state health departments.

8. List of research papers published with authors, year, title, name of the journal and details of MS/MD/Ph.D. thesis submitted or in progress with name of the student and university etc. may be forwarded to us at an early date. This information is required for a special publication on the subject.

9. Financial and Administration:

Present Shri P.B. Saxena, FA, Shri S.C. Sharma, AO and Shri Daral, AcO.

i) Bangalore field station may be allowed to keep Rs. 30,000/- as cash in contingency because of the highly mobile and difficult nature of field work.

ii) It was decided to provide one month advance salary to all the field stations. This action was taken to avoid late payment of salary to the field staff.

iii) Auction of excess tractors, trolleys, jeeps etc. was approved.

iv) One mini truck and one jeep should be shifted from Haldwani to Delhi.

v) Request for replacement of old transport or additional transport should be made with full justification.

vi) All staff/MRC & Projects would be provided Form-16 as a routine action by the administration. Those who need old records to file income tax returns should send request directly to FA.

vii) Dr. R.P. Shukla (Haldwani) should contact Dr. R.S. Yadav for one week training on testing of water quality. Action: Dr. R.P. Shukla.

12.4 SHORTFALLS, IF ANY, AND REMEDIAL ACTION BEING TAKEN

Nil.

12.5 HIGHLIGHTS

12.5.1. Shankargarh, District Allahabad, UP:

Migrant labour for quarry work is routinely screened for malaria; and it was revealed that transmission is aggravated by labour movement from adjoining areas; malaria clinic examined 5270 blood smears which gave SPR=46% and SfR=28.8%; and Pf resistant cases were frequently encountered in the migratory population.

12.5.2 BHEL, District Hardwar , UP:

Malaria control is in the maintenance phase at the BHEL and IDPL complexes and indigenous transmission has been interrupted; at Indian Oil Refinery, Mathura there was major reduction in transmission, neem oil was very effective in repelling anophelines and Aedes; B. thuringiensis was very effective in the control of Ae. aegypti and Ae. albopictus.

12.5.3 Haldwani, District Nainital, UP:

In areas at one time freed from malaria by MRC, focal outbreaks are being recorded. High vector densities in April and May are associated with rice agro-ecosystem. Larvivorous fishes are being maintained in various ponds; biolarvicides produced good control of mosquito breeding.

12.5.4 District Shahjahanpur, UP:

Two units were established to test the bio-larvicides in the control of transmission of malaria and filariasis. Results revealed that spraying produced reduction of mosquito breeding and this impact was visible on adult mosquito populations and on the transmission of malaria. In regard to vector incrimination for filariasis the results are still inconclusive.

12.5.5 Nadiad, District Kheda, Gujarat:

Studies on Narmada project show high mosquitogenic potential. Parasitological surveys showed rise in malaria in villages at one time freed from malaria. There is wide-spread occurrence of Pf resistance. Tests with biolarvicides produced effective control of mosquito breeding and neem oil was a good mosquito repellent. Studies revealed 12.26% relapse rate in P. vivax and after 5 day radical treatment

the relapse rate was reduced to 1.0%; chloroquine resistance in P. falciparum was: RI 10.8%, RII 3.2% and RIII 9.4%; a nigh proportion of asymptomatic carriers in rural areas of Kheda with SPR 8.4% against the SPR of 15.5% in fever cases; breeding of Ae. aegypti (vector of dengue) and An. stephensi (vector of malaria) in the wells and intradomestic containers in villages as a result of piped water supply; and control of mosquito breeding (both Anopheles and Culex) upto 4 weeks with Bs and Bti in the field.

12.5.6 Delhi, UT:

Environmental methods produced good control of sandfly population. Field trials with biolarvicides produced effective control of anophelines and culicines; production and supply of larvivorous fishes; tests with the repellent action of neem oil against mosquitoes and sandfly; Application of remote sensing to map mosquito production in Sanjay lake has been completed; video films for teaching and training purposes are being prepared.

12.5.7 Madras, TN:

Mosquito breeding in the overhead tanks and wells in 3 Corporation divisions is in the maintenance phase; 7 point action plan to control malaria is being implemented by the Madras Municipal Corporation to cover the entire Madras city and; large-scale biolarvicide trials have produced very effective control of mosquito breeding in the city.

12.5.8 Mandla, MP:

Impregnated curtains have produced good impact on malaria transmission as compared to bednets. Neem oil showed good mosquito repellent action. Studies on vivax like parasite showed that it may be a new species. Baseline data has been collected on the mosquitogenic potential of Narmada project.

12.5.9 Sonapur, District Kamrup, Assam:

Studies on the biology of An. minimus are in progress. Insecticide impregnated bednets are entering new areas like the tea gardens etc; malaria surveys in tea gardens showed high transmission resulting in high morbidity and deaths due to malaria; Neem oil was tested for its repellent action on An. minimus. Work on sibling species complex in An. minimus and An. fluviatilis has been initiated.

12.5.10 Rourkela, District Sundergarh, Orissa:

Preparations have been made for a district level introduction of impregnated bednets in collaboration with

state health department and ODA; studies on breeding association of mosquitoes in rice agro-system revealed the presence of 15 culicines and 16 anophelines but had poor relationship with malaria. Trials with biolarvicides produced reduction in mosquito breeding in a variety of habitats.

12.5.11 Car Nicobar (Andaman & Nicobar Islands):

Installation of one way sluice gate has successfully controlled An. sundaicus breeding; there is a consistent decline in transmission of malaria in Car Nicobar island. As a result of bioenvironmental interventions malaria API has come down from 140 in 1989 to 16.71 in 1993. Sphericide produced effective control of An. sundaicus breeding.

12.5.12 Goa:

Surveys along the Konkan railways revealed high mosquitogenic potential and intervention strategies are being worked out. Biolarvicides produced effective control of An. stephensi and Cx. quinquefasciatus. Spraying of biolarvicides produced comparable reduction in mosquito breeding in areas under MRC and state health department. There was interruption of transmission of malaria as a result of spraying of sphericide. Health education material was prepared and circulated.

12.5.13 Bangalore, Karnataka:

A unit has been established for the transfer of technology to control malaria using bioenvironmental method. The unit is at present engaged in geographical reconnaissance of Kolar district. Of the 60 PHCs in the district 3 PHCs have been completed and work is progressing in Gudibanda PHC. Action plan for training and intervention has been prepared and given to the health department. Simultaneously studies have been initiated on sibling species complex in An. culicifacies to understand the changing dynamics of malaria.

12.5.14 Other highlights of the S&T project:

i) Workshops (12) on the engineering methods of malaria control and management of serious and complicated malaria were organized.

ii) Studies on the cost-effectiveness of various methods of malaria control were completed.

iii) Several video programmes were prepared on (a) malaria control (b) biology of the parasite (c) chemotherapy and (d) interviews on malaria vaccine etc.

iv) A variety of health education material e.g., charts, brochures etc were prepared and circulated.

v) Large scale field trials on the application of biolarvicides (Bti and Bs) were launched at the field stations to demonstrate economic feasibility and practicality of the methods in vector control.

vi) Repellent action of neem oil was tested at the field stations and new neem products are being developed for vector control.

vii) Studies on the mosquito breeding in rice agro-ecosystem were launched at various field stations.

12.6 RESEARCH PAPERS PUBLISHED/CONTRIBUTED DURING THE PERIOD UNDER REVIEW

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2. Bhatt, R.N., R.C. Sharma, H.C. Srivastava, A.S. Gautam and D.K. Gupta (1993). Interspecific associations among Anophelines in different breeding habitats of Kheda district, Gujarat: Part II-Non-canal area. Indian J. Malariol., **30**(2): 91-100.

3. Chand, S.K., R.S. Yadav and V.P. Sharma (1993). Seasonality of indoor resting mosquitoes in a broken-forest ecosystem of north-western Orissa. Indian J. Malariol., **30**(3): 145-154.

4. Dua, V.K., S.K. Sharma and V.P. Sharma (1993). Application of Bactoculicide (Bacillus thuringiensis H-14) for controlling mosquito breeding in industrial scrap at BHEL, Hardwar (U.P.). Indian J. Malariol., **30**(1): 17-21.

5. Dua, V.K., Paritosh K. Kar, Suresh Kumar and V.P. Sharma (1993). In-vivo and in-vitro sensitivity of Plasmodium falciparum to chloroquine at Indian Oil Corporation, Mathura (U.P.). Indian J. Malariol., **30**(1): 29-35.

6. Dua, V.K., Reema Sarin and Anil Prakash (1993). Determination of quinine in serum plasma, red blood cells and whole blood in healthy and Plasmodium falciparum malaria cases by high performance liquid chromatography. J. Chromatography. **614**: 67-93.

7. Haq, S., H. Prasad, R.N. Prasad and T. Sharma (1993). Availability and utility of local fishes of Shahjahanpur for mosquito control. Indian J. Malariol., **30**(1): 1-8.

8. Kumari, Roop, Hema Joshi, A. Giri and V.P. Sharma (1993). Feeding preferences of Anopheles sundaicus in Car Nicobar Island. Indian J. Malariol., **30**(4): 201-206.

9. Mittal, P.K., T. Adak and V.P.Sharma (1993). Effect of temperature on toxicity of two bioinsecticides Spherix (Bacillus sphaericus) and Bactoculicide (Bacillus thuringiensis) against larvae of four vector mosquitoes. Indian J. Malariol., **30**(1): 37-44.

10. Mittal, P.K., T. Adak, C.P. Batra and V.P. Sharma (1993). Laboratory and field evaluation of Spherix, a formulation of Bacillus sphaericus (B-101), to control breeding of An.

stephensi and Cx. quinquefasciatus. Indian J. Malariol., 30(2): 81-90.

11. Pant, C.S., D.K. Gupta, R.M. Bhatt, A.S. Gautam and R.C. Sharma (1993). Three genetic markers and malaria in upper caste Hindus of Kheda District of Gujarat State. Indian J. Malariol., 30(4): 229-233.

12. Prasad, R.N., M.K. Das, T. Sharma and G.D.P. Dutta (1993). Prevalence of filariasis in rural areas of Shahjahanpur district (U.P). Indian J. Med Res., 97(A): 112-114.

13. Prasad, H., R.N. Prasad and S. Haq (1993). Control of mosquito breeding through Gambusia affinis in rice fields. Indian J. Malariol., 30(2): 57-65.

14. Sarin, Kumud, Ajay Kumar, Anil Prakash and Arun Sharma (1993). Oxidative stress and antioxidant defence mechanism in Plasmodium vivax malaria before and after chloroquine treatment. Indian J. Malariol., 30(3): 127-134.

15. Sharma, S.N., S.K. Subbarao, D.S. Choudhury and K.C. Pandey (1993). Role of An.culicifacies and An. stephensi in malaria transmission in urban Delhi. Indian J. Malariol., 30(3): 155-168.

16. Sharma, V.P., B.N. Nagpal and Aruna Srivastava (1993). Effectiveness of neem oil mats in repelling mosquitoes. J. R. Soc. Trop. Med. Hyg., 87: 626.

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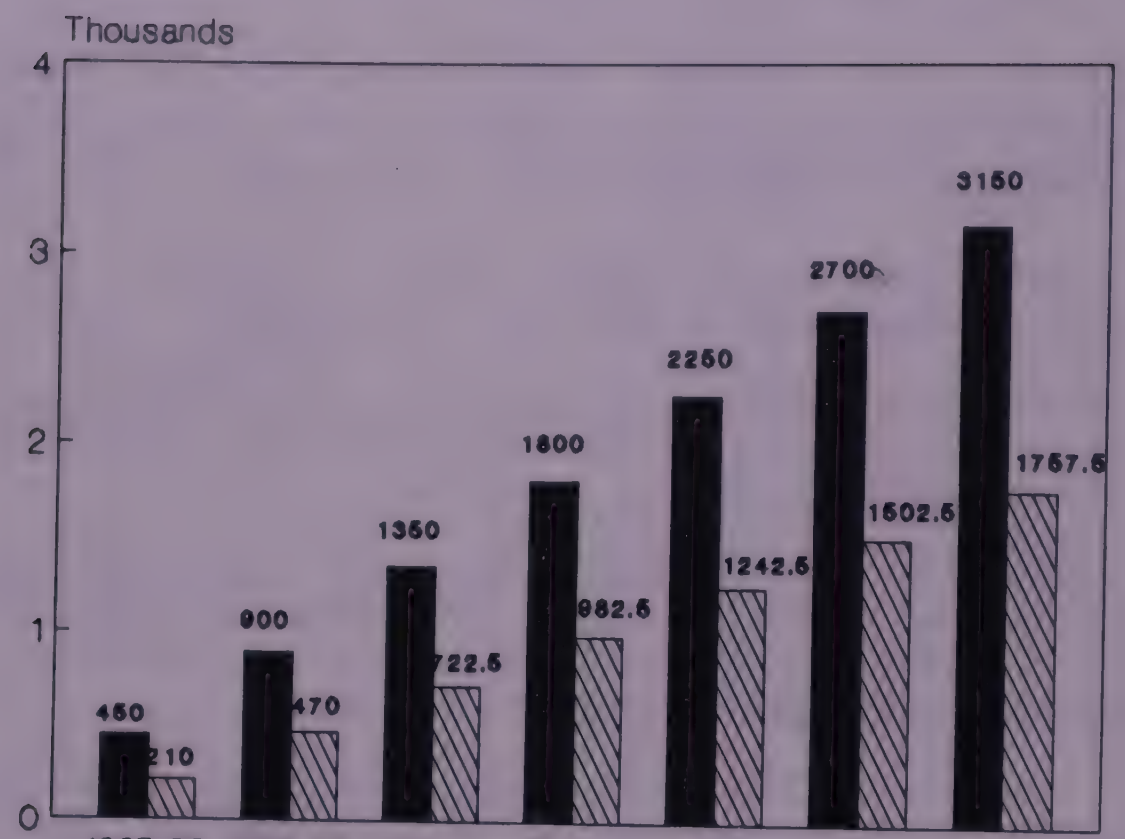
PART III (PHYSICAL TARGETS)

13. Targets for Jan-Dec'94

Quarterly financial targets for 1993-94 are shown below:



LIST OF WORKSHOPS ON TRANSFER OF TECHNOLOGY IN IDVC APPROACH FOR MALARIA CONTROL

a. **WHO sponsored workshop for malaria control through IDVC approach for engineers, architects , town planners, medical and public health specialists.**

i) Malaria Research Centre, Field Station, Goa.
(1-5 March 1993)

ii) Malaria Research Centre, Field Station, Sonapur, Assam.
(10-12 March 1993)

iii) Malaria Research Centre, Field Station, Rourkela.
(22-26 March 1993).

b. **Private sector sponsored workshop for engineers, public health specialists in engineering methods of control.**

i) Tarajuli Tea Estate, Tejpur.
(21 May 1993)

ii) Mathura Refinery Mathura.
(5 December 1993)

c. **Ministry of Defence sponsored workshop for engineers and public health specialists in engineering methods of control.**

i) Malaria Research Centre, Delhi.
(19-21 July 1993)

ii) Military Base Hospital, Gawahati.
(13-15 September 1993)

iii) Air Force Station, Agra.
(19-21 October 1993)

iv) Air Force Station, Tambaram, Madras.
(6-8 December 1993)

d. **Delhi Development Authority sponsored workshop for engineers in engineering methods of control.**

i) DDA Training Centre, Vikas Sadan, New Delhi

a) 12-19 February 1993

b) 15-18 December 1993

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